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ABSTRACT

The complete proceedings of a one-day conference on educating women for science are presented. Career profiles for eight participants are followed by papers presented in 14 discussion groups. An alphabetical listing of American women scientists and their field of science is included. (MH)

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Educating women for science: A continuous spectrum

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A One-Day Conference at Mills College
Sponsored by Center for Teaching and Learning,
a Danforth supported office at Stanford University
Saturday, April 24, 1976
Concert Hall, Mills College, Oakland, California

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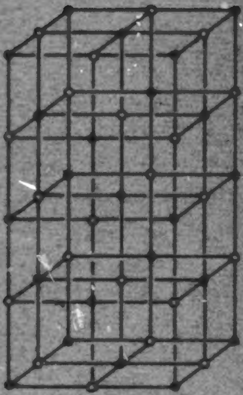

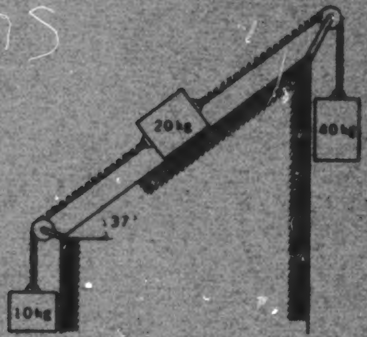

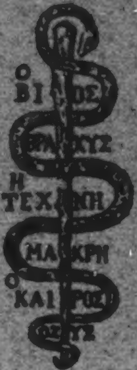

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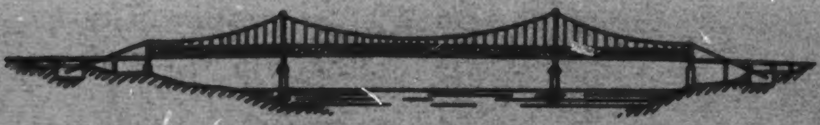

SE 022 108

EDUCATING WOMEN FOR SCIENCE: A CONTINUOUS SPECTRUM

Proceedings of a one-day conference held at Mills College, April 24, 1976. The conference was sponsored by the Center for Teaching and Learning, a Danforth supported office at Stanford University.

The Center would like to express gratitude to Syntex Corporation for its generosity in publishing and mailing the conference proceedings and directory.

EDUCATING WOMEN FOR SCIENCE: A CONTINUOUS SPECTRUM

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9:00 a.m.	**Welcome**, Lenore Blum, Prof. of Mathematics, Mills College	Concert Hall
	Introductory Remarks, Jean Fetter, Assoc. Director, Center for Teaching & Learning, Stanford University	
	Keynote Speech, Estelle Ramey, Prof. of Physiology & Biophysics, Georgetown University	
10:00 a.m.	**Coffee**	Concert Hall Lobby
10:30 a.m.	**Career Profiles & Question Period**	Concert Hall
	Moderator: Ravenna Helson, Assoc. Research Psychologist, University of Cal., Berkeley	
	Biologist: Ellen Weaver, Prof., Biology, and Director of Sponsored Research, S.J. State U.	
	Chemist: Sharon Brauman, Sr. Research Chemist, Stanford Research Institute	
	Engineer: Ruth Gordon, Sr. Structural Engineer, State of Cal. Structural Safety Section	
	Mathematician: Elizabeth Scott, Prof. Statistics, U. of Cal., Berkeley	
	M.D.: Christina Harbury, Prof. of Hematology, Stanford Med. School	
	Physicist: Elizabeth Rauscher, Theoretical Nuclear Physicist, Lawrence Berkeley Laboratory	
	Scientific Administrator, Ruth Havemeyer, Product Development Manager, Syntex Corp.	
12:00 p.m.	**Lunch**	Founders Commons

1:45 p.m. **Discussion Groups** *

1.	Cooperative Programs in Engineering, Mary Lou Allen	Bldg. 25 Rm. 27
2.	Educating College Women In Math. Lenore Blum	Bldg. 22 Rm. 206
3.	Minority Women in Science, Rosalie Deslonde	Bldg. 25 Rm. 23
4.	Pre-college Preparation for Math & Science Graduates, Judith Forcada	Bldg. 22 Rm. 201
5.	A New Concept of Affirmative Action for Women, Lynn Fox	Bldg. 25 Rm. 35
6.	Problems of the Female Pre-med and Medical Student, Laurel Glass	Bldg. 32 Rm. 518
7.	Creativity in Women Mathematicians, Ravenna Helson	Bldg. 22 Rm. 205
8.	Why & When Young Women Get Deflected from Science, Barbara Kirk	Bldg. 25 Rm. 6
9.	Action Programs to Motivate Young Women, Nancy Kreinberg and Rita Liff	Bldg. 25 Rm. 26
10.	Career Re-entry/Upgrading, Peggy Shoenhair	Bldg. 32 Rm. 515
11.	Admission and Attrition of Women in the Sciences, Lucy Sells	Bldg. 22 Rm. 207
12.	Jobs for Women in Science, Sandra Slivinsky and Marlys Hansen	Bldg. 25 Rm. 14/1
13.	A Counselor's Perspectives, Jackie Yokote	Bldg. 25 Rm. 5
14.	Courses on "Women in Science", Barbara Webster	Bldg. 25 Rm. 7

3:00 p.m.	**Coffee**	Concert Hall Lobby
3:30 p.m.	**What Next?**, Jean Fetter	Concert Hall
4:15 p.m.	**Closing Remarks**, Lenore Blum	

* Bldg. 22 = Physical Sciences & Mathematics
Bldg. 25 = Lucie Stern Hall
Bldg. 32 = Life Sciences Building

WELCOMING REMARKS

Lenore Blum: Professor of Math. Mills College

Hello, I'm Lenore Blum, head of the math-computer department at Mills. We are very pleased to be hosting this conference "Educating Women for Science: A Continuous Spectrum" on Mills campus today. Mills is now completing the second year of an extensive "Women in Science" program. This program is funded in part by grants from the San Francisco Foundation and IBM. It had the goal to create the environment and atmosphere where it can be as natural for women to take courses in math and sciences as it has been in the past in the humanities and fine arts; where women can view careers in science and technology as exciting and viable opportunities. So we have a very special interest in the goals of this conference today. I am delighted to see you here and would like to welcome you to Mills. I hope this day will prove to be a profitable, enjoyable and stimulating experience for you, where ideas can be shared; perhaps more importantly where contact can be made and new directions charted.

Now, I'd like to introduce Dr. Jean Fetter, Associate Director at the Center for Teaching and Learning at Stanford University.

"EDUCATING WOMEN FOR SCIENCE: A CONTINUOUS SPECTRUM"

INTRODUCTORY REMARKS

Dr. Jean Fetter, Associate Director
Center for Teaching & Learning, Stanford

A favorite pastime of the scientist is asking questions and I'd like to begin with two: Why are we here today? How did this conference at Mills come about? Continuing this scientific approach, I'll answer the easier (latter) question first. Its answer has something in common with a number of scientific discoveries such as the discovery of radioactivity, the mysterious pulsars or penicillin; it was the result of pure chance. But, as was the case in these scientific breakthroughs, a receptive mind can often mold chance happenings into significant events and I hope today will be significant to Bay Area women in science.

One day last October, Doris Herrick, the associate director of development at Mills College, called Stanford to inquire about a program in faculty development. An unknowing telephone operator connected her with my office. I couldn't help with Doris's question but it set off a lengthy and interesting conversation. We made a tentative agreement to work on a cooperative project on Bay Area women in higher education. The aim of the Center for Teaching and Learning, a Danforth supported office, is to improve teaching in Bay Area colleges by cooperative efforts, so this idea was both feasible and legitimate. Before joining the Center, I had taught physics for a number of years and was always delighted to see women students in my classes--unfortunately, a rare occurence. The vague idea of "Women in Higher Education" began to crystallize; why not a conference on Bay Area women in science involving a spectrum of faculty from high school through college? Which brings me back to the first question. Why is this problem significant?

Alice Rossi, writing on "Women in Science" in SCIENCE magazine in 1965 noted that of all natural scientists, only 9% are female with less than 1% as engineers. Vera Kistiakowsky, an M.I.T. physicist, prepared a report in 1973 on women in Engineering, Medicine and Science; the percentage of scientific women is still hovering around 9% although the number of engineers seems to have just passed the 1% mark. These numbers would be acceptable and reasonable if the proportion of women in the total population was comparable. But women constitute more than 50% of the total population in the United States. Another perspective comes from some recent UC Berkeley statistics. Fifty-seven per cent of the male applicants to UCB had completed four years of high school math compared to 8% of the female applicants. Lucy Sells labelled high school mathematics as the "critical filter" in the job market; it is certainly a major obstacle for women's entry into scientific careers. Given these figures it is not surprising to see Vera Kistiakowsky report that in a survey of leading universities, the percentage of women as both full and associate professors in physics and mathematics is between 1 and 2%.

With this bleak picture, the next obvious question is but why educate women as scientists? Today, we are fortunate to have Dr. Ramey here to present one answer to this question. Estelle Ramey, unlike Spiro Agnew, seems to be a household word. (Selections from the following resumé.)

"I was born in Detroit, Michigan in 1917 just as women were tooling up for the right to vote. I got out of college at the age of 19 in the midst of the great depression and was offered a job as a Teaching Fellow in the Department of Chemistry of the newly organized Queens College in NYC by a former professor of mine. The salary was $750 a year and thousands of bright young men would have leaped at the opportunity. Fortunately for me, Dr. Whittaker, my old teacher, did not regard gender as a determinant for jobs. Even though I had been a biologist I gladly took an advanced degree (M.A., 1940) in Physical Chemistry at Columbia University in order to keep the job. In 1941 just as I became a full time Instructor in Chemistry, I married a young law student named James T. Ramey and found myself in Knoxville, Tenn., where he had gotten his first job as a lawyer with the TVA.

I applied for a job to the Department of Chemistry at the University of Tennessee in Knoxville and was brusquely informed by the then Chairman of the Department that he had never hired a women, would never hire a woman and that I ought to go home and take care of my husband. A few months later the Japanese bombed Pearl Harbor and the Chemistry Department at the University began to lose its staff. I got a call from a chastened Chairman and was offered a job teaching chemistry to Air Cadets and Nurse Cadets. By that time I had taken such good care of my husband that I was pregnant but I worked part time anyway and continued through the war and two children, teaching chemistry at the University of Tennessee and doing a little research. At the war's end my husband joined the newly created Atomic Energy Commission as Regional Counsel of the AEC in Chicago. I then became a student at the University of Chicago Medical School and ended up with a doctorate with specialty training in endocrinology. When I got my degree in 1950 I was awarded a U.S. Public Health Service Postdoctoral Fellowship in Endocrinology to work at the Michael Reese Hospital Research Institute in Chicago and an Assistant Professorship in the Department of Physiology at the University of Chicago School of Medicine. I taught endocrinology to medical students and trained several Ph.D. candidates in endocrinology during the next six years in Chicago. During these years I did research in the area of the relationship of glands and the nervous system to stress responses and began to do work also in the field of diabetes mellitus.

In 1956 my husband was offered the job of Executive Director of the Joint Congressional Committee on Atomic Energy and we moved to Washington. I joined the staff of the Georgetown University Medical School where I am now Professor of Physiology and Biophysics. I have continued my endocrine research and teaching of medical, dental and graduate students. My administrative responsibilities have included the Acting Chairmanship of my Department while the permanent Chairman was on leave and I was Vice President of the Washington Heart Association and am a member of their Board of Directors. My husband was appointed by John Kennedy and reappointed by Lyndon Johnson as a member of the U.S. Atomic Energy Commission. He is presently Special Advisor to the Joint Congressional Committee on Atomic Energy and Vice President at Stone and Webster Engineering Corp.

My research output is represented by more than 150 papers published in scientific journals and two books. My ventures into the popular press include an article in McCall's and then in the Reader's Digest on the subject of the Fragility of the Male Sex and more recently in the first issue of the new feminist magazine Ms. with an article called: "Male Cycles-They Have Them Too".

My maternal output is a source of great pride. My son, Dr. James N. Ramey was Chief Medical Officer of the Indian Health Service Hospital on the Sioux Indian Reservation in Pine Ridge, South Dakota. At present he is a Resident in Medicine at Yale Medical School and the father of my remarkable grandson. My daughter, Drucilla S. Ramey was Magna Cum Laude from Radcliffe, and recently graduated from Yale Law School after a stint as one of Nader's Raiders. She has started a law career in San Francisco in the area of "pro bono" litigation, and is currently a senior staff attorney for the Mexican-American Legal Defense Fund of America.

At present I am giving a lot of my energies to the women's rights movement which

I consider to be a facet of the endless struggle for human development.

My official positions in the women's rights movement include:

Member, Commission on Human Resources, National Academy of Sciences
President of the Association of Women in Science
Chairman, Committee on the Status of Women in The Endocrine Society
Vice-President of Women's Equity Action League (WEAL) of Maryland
Convenor, Women's Political Caucus of Maryland
Guest Lecturer: Institute for the Continuing Education of Women, University of Cal., Berkeley
Women's Forum, Yale University, New Haven
U.S. Dept. of State, Women's Forum
U.S. Dept. of Agriculture Graduate School
U.S. Dept. of Interior, EEO Program
U.S. Gen. Services Admin., EEO Program
Science Seminar, AEC, Los Alamos
And many more organizations throughout the country
Member, Board of Directors, International Institute of Women's Studies
Member, Board of Directors, Greater Washington Educational Telecomcunications Assoc., Inc. (WETA) and the National Public Affairs Center for Television (NPACT)
Member, Board of Directors, Washington Heart Association
Member, Board of Directors, Madeira School, Virginia

Honors: Phi Beta Kappa, Sigma Xi, Mergler Scholar in Physiology, University of Chicago
U.S. Public Health Service Postdoctorate Fellow, 1972 Washingtonian of the Year Award (one of 12 Washingtonians selected by the Washingtonian Magazine for this award, me and Larry Brown of the Redskins!)
Distinguished Alumna of the Year 1973, University of Chicago"

I have never heard Dr. Ramey speak but her reputation is enviable. In a recent conference organized by ERDA, evaluations rated her as "the best on the program". In 1970 she did not hesitate to debate Dr. Edgar Berman, a member of a Democratic Party advisory group and Senator Hubert Humphrey's physician. He had declared that women were unfit to hold high public office because the "raging hormonal imbalances" brought on by the menstrual cycle and menopause made them unstable.

We appreciate Dr. Ramey's effort in travelling 3,000 miles, between her Thursday and Monday classes, to speak to us today.

Dr. Estelle Ramey – Keynote Speaker
Professor of Physiology and Biophysics
Georgetown University

WHY EDUCATE WOMEN AS SCIENTISTS

Dr. Estelle Ramey

Professor, Dept. Physiology & Biophysics
Georgetown University School of Medicine

I am very glad to be here. Several years ago, I spoke to a women's group here at Mills College. It is difficult to remember how many years have passed since then because not much has changed in substantive terms in the advancement of women in the job market. The rate of increase in line jobs in academic science for women is so slow that I can easily use the same speech for several years running. The thing that has changed, however, is the awareness of the society that somehow women are not as tractable or as bidable as in the past.

This awareness together with the laws on the books has produced a variety of studies, commissions and task forces to substitute motion and activity for actual progress for women in science. I am a member of a Commission of Human Resources created under the aegis of the National Academy of Sciences through the National Research Council. I am the only female resource on that Commission and we also have one black man. This is the usual format of such outfits. The white middle aged who comprise the rest of the membership are uniformly distinguished, well meaning and decent people. The problems we cope with are not amenable to the techniques used by these nice men in the past. It is my experience that all such committees are constituted in much the same way. The more prestigious the group, the fewer the women members but there is at least one. Perhaps that does indicate progress because in the recent past the only women present in the Board room of such enterprises have been the note takers and the coffee makers. Tokenism may be better than nothingism but not much better in terms of clout.

It is also to be noted that the role of women in science is viewed as a problem similar to the role of blacks in science. There are obvious and superficial similarities, to be sure. What is lost to view in all such joining of the two histories of discrimination is that white women have been educated in huge numbers for many years now in this country and constitute a large pool of skilled scientists. To our shame, the United States has consistently ignored the education of its black citizens until relatively recently. That pool of trained scientists is thus much smaller even when black men are counted, let alone black women. During the period of slavery, it was a serious crime in many states to educate a black person. It was an example of pragmatic evaluation of an unacknowledged phenomenon; to wit: it is dangerous to educate and train a human brain if you want that brain to be docile. When you educate any member of the species Homo sapiens,"the thinking ones," you are in for questioning of the status quo. You are in for trouble.

Women were similarly uneducated for centuries but the natural resources and technological development of this country began to produce the kind of wealth that made it possible to add a kind of frill to the preparation of women for middle and upper class marriages. How nice to have a wife who could discuss literature and music in the drawing room with one's associates. Soon women's education became identical in many respects to the goal oriented male education and went far beyond the tinkling graces of social display.

The result is that we have many women scientists but for most of us, it has been regarded as a non-serious preoccupation with knowledge. Despite our numbers, we somehow get lost on the way to tenure and all decision making jobs in the scientific community. Academia is as uninterested in women as the most "unintellectual" corporation. The record of job advancement for women in science in universities is a blot on that putative ivory tower of pure thought. It is passing ironic that women are lumped into the same category as numerically minority groups. We are upwards of 52% of the population. Every politician in the country would be well satisfied with such a "minority" vote. Yet there we are in a minority status as regards all the societal regards of careers, money and status.

Because of subtle and not so subtle conditioning, women have been discouraged consistently from entering certain of the sciences. These include all the quantitive, mathematical areas such as physics, engineering and chemistry. The pools of trained women in those fields is thus small. But this seems to be irrelevant in any case. In those more "feminine" fields like the life sciences and the social sciences where the percent of women Ph.D's is as high as 30% of the total pool, the unemployment or underemployment of women remains high. The rate of unemployment for women biochemists for example is estimated at three times that of similarly qualified men seeking jobs. In physics, given even the pitifully small pool of trained women seeking jobs, the unemployment rate may be as high as 10 times that for men. So much for all the heart burning about "reverse discrimination" and its evils. I am regaled constantly by earnest men (and often women whose sons are job hunting) with statements that women scientists have it made these days. All a woman has to do, according to these social historians, is to notify the Chairman of a science department at Harvard is that she is available and will accept a tenured Professorship and behold, a male Nobel Laureate is summarily discharged and the unqualified woman is hired in his place. This kind of facile mythology is accepted by otherwise knowledgable people. One has only to look at the statistics for women employed in science in the last 5 years to see the vicious distortion of the facts. In many institutions there is actually a lower percentage of women executives than in 1970. More women are coming in at entry ranks but only a miniscule number are moving up rapidly.

Recent court decisions are making it easier for universities to follow their natural bent and ignore the spirit as well as the letter of the laws granting civil rights to women. No university has been penalized for discriminatory practices by having its Federal funding curtailed even when proven discrimination has been demonstrated. They have been given world enough and time to mend their ways. It is calculated that at the rate they are mending, it will take 300 years to establish a healthy academic corpus. I don't have that much time to wait. Affirmative talk is widespread. Affirmative action remains a small and increasingly vilified concept. Everybody indignantly decries quotas and special privilege and every instituion gives special treatment to sons of alumni, sons of big donors, sons of important politicians, sons of powerful faculty members and administrators. This is traditional and kosher. It should not be confused with the heinous practice of giving some help to the daughters of that same institution. For years Harvard selected some of the most brilliant young women in our society, allowed them to earn doctorates in the sciences and then ignored them in the job competition. Their own distinguished graduates were not considered employable because testicles are written into the job descriptions. And Harvard is not any different from any other institution. Junior colleges at the status job level are just as hung up on maleness. It is accepted wisdom that testosterone is the take charge hormone and that estrogens poison the cerebral cortex.

At Stanford University the absolute number of tenured women is below what it was 5 years ago and Stanford now has a vigorous program to recruit "outstanding" women. This is posited on the notion that every tenured member of the Stanford faculty is an Albert Einstein manqué and that a few are reincarnations of Isaac Newton. That has not been my experience with Stanford or any other first class institution of higher learning. Each has a number of very bright productive men, an equal number of damned fools and a very large contingent of respectable hacks. Now that women are being saught to comply within reason with the law of the land, a few women are receiving requests for CV's from many schools and institutes. This small group of women scientists has managed to be productive under acknowledged obstacles. Some always get through. I had an uncle who refused to recognize that there was discrimination against blacks. He used to say: "Booker T. Washington made it. All it takes is hard work and ability." Well, it takes a lot more than that if you are a woman in science.

As a past President of the Association for Women in Science, I got a good look at the history of women scientists just by reading the CV's of many productive and hard working women. Indeed, our first President, the late Dr. Judith Pool was herself a case in point. She was for many years a highly innovative and respected hematologist on the staff at Stanford Medical School. Her rank remained Research Associate despite an international reputation for excellence. Only after the women's movement gathered its small momentum was she appointed a full professor in one swoop. The tragedy of Judith Pool is that she could savor this victory for only a few years before her untimely death. Dr. Mildred Cohen, one of the rare women to breach the impenetrable ranks of the National Academy of Sciences, that Cosa Nostra of the academic community, had been a research associate for 21 years before she, too attained permanent academic rank. This is no way to run a society or a university but it is the way we have been doing it.

At present, there are departments that use the affirmative action regulations for their own hiring techniques. I have observed on several occasions that a young man is told by a disinterested department chairman that he would like to hire him but is under the gun to hire a woman. This lets the chairman off the disagreeable hook and infuriates (understandably) the young man who than tells everybody about reverse discrimination and its injustice. (Women have been consistently bypassed for male applicants but that's life.) What the young man seldom knows is that a month or two later, that same department hires a man closer to its heart's desire and business goes on as usual. Thus women have made an implacable enemy without even getting the job rewards. Heads I win, tails you lose.

Women in science have the problem of always being referred to as women scientists. Have you ever heard of a nurse referred to as a woman nurse, or a secretary as a woman secretary? It is always a "woman" doctor or a "woman" executive as if the status jobs are uniquely male and only a miracle produces a female of the species. This kind of identification is unnecessary in their low status counterparts. This is however, a matter of conditioning. When my son was 4 years old, he heard somebody refer to me as a "woman scientist." Some time later he said to me: "Mommie is there such of a thing as a man scientist?" I assured him that there were a few but they weren't dependable. Thirty years later, that same son is a man doctor and his son, my remarkable grandson is a bit confused by the conflicting messages he's getting. His mother is a medical student. He hears me called Dr. Ramey and yet all those other little beasts at school keep telling him that only boys get to be doctors, girls are nurses. Kids like to have families that conform. Fortunately, more and more young women, like his mother are becoming "women doctors." Perhaps when my grandson is my age, that great compendium called American Men and Women in Science will have changed its name to American Scientists. For most of my scientific career I was listed in that roster when it was called American Men of Science and nobody thought that was rather unscientific, despite my obvious credentials as a female. If they are determined to categorize scientists by sex, I think the name should be changed to American Men, Women and Hermaphrodites in Science.

Women have to learn the unwritten rules of the game. I have observed over the years that gamesmanship in science is just as important as in any other competitive area. It is not enough to be a good scientist, a young man on the make learns the value of sponsorship by an older man. He learns how to make his presence felt at scientific meetings, how to ask questions after important presentations, how to meet and talk to the powerful and the brilliant. I was myself helped by just such a sponsor. He introduced me to people who had clout in my field. He encouraged me to speak up in discussions. I have tried to do this with my own women graduate students. A young woman should be pushed into asking questions at national meetings to give her name loud and clear and to comment on work in her own field. Mousey behavior gets you treated as a mouse. You don't get noticed. You don't get tapped to committees. You don't get asked to chair sessions. It's not that anybody actively puts you down, women just don't get a lift up. Justice must not only be done, it must be seen to be done. If the administrative honors of scientific societies are insignificant, then why do so many distinguished men strive to acquire those appointments. There must be some pay dirt in the boring work of a committee membership or all those classy fellows wouldn't lust for them so. Careers are built on many stones, including peer group recognition.

Scientific societies are run by the opinion makers of that discipline. These men are very important when it comes to passing the cookies in the job raffle. When there's a nice opening in some department, what is more convenient than calling the guy you served with in the socicty and asking him if he knows a "bright young man" who has potential. Nobody seems to ask for a "bright young woman." After all it's risky hiring a young woman. She might get married or pregnant. And if that doesn't happen she might do even worse. She'll stay around and then become menopausal and who wants a menopausal woman in the department. Not a menopausal man.

My own speciality is endocrinology. The Endocrine Society like all such scientific societies has not been distinguished by its recognition of outstanding women in the field. It has been for years an old boys club at the officer level. This is not to say that male endocrinologists do not like women. They love women, just like Henry the Eighth. There has never been a woman president of the society despite the fact that endocrinology has a large number of women professionals. But numbers alone do not guarantee representation in the board room. After all, the USSR has women receiving 70% or all its M.D. degrees yet only 10% of prestigious Russian National Academy of Medicine are women. It takes more than just numbers of women achievers apparently to overcome the ancient and universal view by women and men alike that women are somehow not as adequate to the job.

At the present time we are seeing an increase in women physicists and astronomers from 1% to 4.3% of doctorates awarded. In chemistry we have gone from 5 to 9.7%. The biological sciences are holding at about 22%. Psychology is up to 31% as is anthropology and sociology. Women medical students are up to more than 20% of the class. And so we have coming out of the pipe line an increasing number of highly trained women scientists. The unemployment rate is also high. In physics it is 29% for women, 10 times higher than for men comparably trained and experienced. Despite this, I hear on all sides that women are taking "men's jobs" or their places in medical school. On which tablets of stone is it written that there are men's jobs as distinct from women's jobs? Women must learn that there is no nice way to take power from the entrenched powerful. Men learned this and formed trade unions. A single man, poor and powerless had no chance agaisnt the boss. Now big labor is a match for big business. You don't have to like every member of your union. You just recognize a mutuality of self interest and act accordingly.

Women have to learn "I am my sister's keeper." There is no special feminine mystique in this, no saintlike self abnegation--just plain self interest and a commonality of problems. Only women know what it is like to be a woman in a world run by men. To be sure, American women are luckier than the starving women of India but we are also the richest nation in the history of human beings. Women are still teaching their sons to trivialize the accomplishments of women. Women have self images that have no resemblance to the truth of their strength and intellect. Take a good look at the male competition in science. It ranges from awesome (a few) to not much. Not all men are geniuses. Why should women expect so much of themselves when they settle for so little so often in their men.

Equality is not when a female genius gets an entry level instructorship. Equality is when a mediocre female assistant professor gets promoted as fast as a mediocre male assistant professor. That's equality. For those few women who have earned and achieved security there is an obligation to help other younger women as older men help their successors. Role models of women in top science are scarce but they do exist. Young women must set high goals for themselves if they are going to make the run for the roses. This society has to stop talking out of both sides of its mouth. We are spending billions of dollars each year to educate women in higher education. That investment has yielded low dividends because we refuse to discard the old myths. We must fish or cut bait. Either go back to keeping women barefoot and pregnant or use their expensively and hard earned skills for the greater good of all women and men. A woman's destiny lies in her head not in her tail. We are biologic marvels. We need not destroy ourselves in the way men have done in order to develop and use our potential. Women have been trained to a more nurturing and caring stereotype. This is all to the good if it is not distorted to a pinheaded, masochistic pattern that is a disaster for both sexes.

I have a poster given to me by my daughter (that's my daughter, the lawyer). It is a take-off on the Michelangelo masterpeice at the Sistine Chapel. Instead of a muscular God creating a muscular man, however, my poster has a very feminine God with an Afro stretching out a lovely female arm to create a beautiful blond. The legend under my poster says: "And God Created Woman in Her Own Image."

Ellen Weaver – Panelist
Biologist and Director of Sponsored Research
San Jose State University

"CAREER PROFILES"

Ellen C. Weaver, Biologist
Director, Sponsored Research
San Jose State University

Today I am working as an administrator but consider myself a biologist and speak of the challenges, problems, and satisfactions of the scientific life I've had.

I decided rather late to become a biologist. Although I had majored in chemistry, it was in order to put my physicist husband through graduate school back in the days when there were no government grants. In fact, I don't think I planned a lifetime career of any sort. When I was 25, I read a book by George Corner entitled "OURSELVES UNBORN" which kindled my interest. I was admitted to Stanford, Department of Biological Sciences. I must have seemed a rather unpromising prospect since I'd had no undergraduate biology at all. However, I got a Master's Degree there working on the genetics of a green algae. Even then it was months later during a year spent in Switzerland that I decided to finish up and get the Ph.D. I bore my children while a graduate student at Berkeley - which was really an uninspiring grind for the most part, doing a thesis project on fruit flies.

What really determined my activities for the next 10 years was the observation that photosynthesis organisms become paramagnetic when exposed to visible light. My husband had played a major role in development of the early instrumentation which made detection of this phenomenon possible. By the time I finished my degree, others had made the same observations and there was considerable excitement with the feeling that perhaps we had a handle on the primary physical event in photosynthesis and I decided to try to determine the origin and significance of this light induced (electron paramagnetic resonance) EPR signal. The problem was not easily solved and of course I did not have it to myself. But I did succeed in finding equipment, getting funding, and doing some experiments which increased our understanding of the action of light on plants. That was the challenge and it involved my mastering concepts and techniques in which I had no formal training.

The satisfactions came from asking nature some questions and getting - at least occasionally - a clear-cut answer. Experimental work is creative and good, clean answers produce a euphoria that is absolutely addicting.

One of the pleasures of science is the meeting or symposium or conference. A good meeting is the best of gatherings, providing stimulus and ideas which are vital, particularly if one works alone. Moreover, I was able to attend them in interesting places such as Vienna, London, Tokyo, and Moscow. The trip is a nice reward for the thousands of laboratory hours and very important for one's growth as a scientist.

What I did not succeed in doing was to secure a suitable position in which to do research, with or without teaching.

It was probably a mistake to get a doctorate on a topic which did not seem burningly important to me. At the time, merely getting the degree was the prime aim. Changing fields means you don't have credentials and your professors can't or won't help you become established. I was not a part of any accepted discipline, and thus did not easily fit any academic department.

In addition, being a woman is a handicap. If a department has never had a woman on a tenure track, it is easy for them to say, *"There is no woman good enough to be a member of our department."* But what was even sadder was the comment of a woman friend, research associate in that department,who said, *"Oh, Ellen, he's right. It's an awfully good department."*

"We hired a woman once and you know what happened? She got married! I'll never take that chance again."

"I've never hired a woman because I don't know how she would get along with the faculty wives."

"I never encourage women to become chemists - they don't have the right kind of minds."

If a professor has never had a woman student who goes on to become a serious scientist, it is easy for him to say, *"Women don't want to make a career out of science."* If one happens to be a woman who does, it is hard to convince a majority of a department to take a chance on you. In addition, women with families are really not mobile in the way most men are and can't range far in search of a job.

A competent woman does pose a threat to many a man who will see to it she doesn't advance. I hope that is changing.

The satisfactions and challenges are much the same for both women and men scientists. Let's hope the problems will eventually be no greater for women than for men, and that the good mind and particular character which makes one a scientist will not be viewed as a sex-limited characteristic.

Sharon Brauman – Panelist
Senior Research Chemist
Stanford Research Institute

Sharon K. Brauman
Stanford Research Institute
Senior Research Chemist

What influenced my choice of career?

My early career began without much conscious direction on my part. Like most people, I was attracted to those subjects in school which I enjoyed, in which I did well, and in which I was encouraged. For me, these subjects were science and, in particular, chemistry. I was first exposed to science, besides math, in high school and the science program there was quite limited--math, chemistry, and biology. Options were not available in some areas in which I now realize I could enjoy an equally rewarding career. However, this is a moot point since I'm quite happy in chemistry.

After high school, my course became somewhat more directed. I did select and attend an undergraduate college (Mount Holyoke College) with a good science reputation, especially in chemistry. This conscious direction was reinforced by summer employment in various university and industrial laboratories.

Up to the time I entered graduate school at UC-Berkeley, this background probably sounds like that of many another professional scientist. However, in retrospect, I see one major difference that I feel as a woman was probably very important in my choice of career--that I attended girls' schools, twelve years of preparatory school and four years of college. This had many good features: 1) I was able to pursue studies in any field I desired, 2) I was encouraged in the field of my choice, 3) I had many female role models, and 4) there were many other female science majors. I don't recall being encouraged individually so much. Expectations for everyone were high. From high school, everyone went on to college and from college, a large fraction went on to some form of higher or continuing education.

Probably as a result of attending girls' schools, I was in graduate school before anyone ever challenged me as to what I was doing. Fortunately, I had reached an age where I could handle such an affront without being discouraged. I think postponing such discrimination is probably advantageous. However, you might consider it an unrealistic consequence of obtaining an all-female education.

What are my greatest challenges?

My single biggest challenge is my work at SRI as a research chemist. Generally, it is a positive, rewarding challenge to achieve my goals of defining and solving research problems, directing the laboratory staff, publishing papers, giving presentations, keeping up with the literature, generally interacting with the scientific community, and obtaining necessary funding. This is all part of my job as a Senior Chemist in a contract research organization.

I also have several other hats that I wear really to meet the challenge of keeping my options open for a varied and interesting career. As Associate Manager of the Polymer Chemistry Group at SRI, I have certain management opportunities. As a Visiting Lecturer in Chemistry at Stanford University, I have been teaching organic chemistry to undergraduates. And finally, I've been serving in what I will generalize as an advisory capacity in various science vocational programs such as this one or the new VIEW program some of you will hear about later on. Keeping your options open can be a great challenge. It's very important, it can be very difficult, but it also can be a lot of fun.

What are my greatest problems?

My problems are any obstacles to my achieving my goals as a research chemist. Frankly, these are not special women's problems, but rather problems facing all professional chemists. The biggest immediate problem for me and my colleagues at SRI is to define research areas that are marketable and in which we are interested.

I don't mean to imply that I have never experienced sex discrimination in my career. However, it has been quite infrequent. By hard work, persistence, and, in particular, high quality work, I easily and quickly had the respect of my peers. The major reason for this is that the criteria by which you are evaluated in most areas of research in the hard sciences are quite objective. Most science problems have real solutions or answers and if you can define the problems and come up with the answers, it will be most apparent. Hand-waving won't get you very far. I believe this objectivity is a very good reason for encouraging women to enter science. However, the system is egalitarian enough so that even women can be terminated. With that realistic note, I conclude my comments.

Ruth Gordon – Panelist
Senior Structural Engineer
State of California Structural Safety Section

in Civil Engineering.

In our sophomore lab courses--forging, foundry, welding, surveying and concrete mixing--the three of us would wear jeans and show up in them at dinner, there not being time to change. At that time, this was not done. One Monday night at house meetings all over campus, it was announced that certain women were improperly dressed "below the post-office" (a local dividing line for "quad" or classroom clothes). I pointed out that if the University paid my cleaning bills I'd wear "quad" clothes in lab. A few days later a boxed notice appeared on the front page of the Stanford Daily that women were to wear "quad"clothes below the post-office except for certain specified lab courses.

Our biggest problem was that the men had "files" of old exams and problem sets and helpful upperclassmen in their residences and we did not and so had to work harder.

There were helpful professors, though: Professor Reynolds, sanitary and water supply engineering, and his wife who "parented" me, and Professor Oglesby, transportation and construction, whose wife was a professional woman. They were instrumental in my being awarded two scholarships for graduate school, the first time they were given to a woman, one of the criteria being the expectation that the recipient be successful in the profession, quite something to live up to.

Jobs at that time? During the war in summers I worked at a defense plant as a draftsman. However, the day after V-J Day a number of women in technical jobs were told either to take a typing job at lower pay or quit. The summer before I went to graduate school, I was bombarded with letters from a bathing-suit manufacturer who wanted to hire a woman engineer to design bathing suits from a structural standpoint. It was obviously an advertising stunt and the salary they offered was clerical. One of the local colleges was offering an instructor's position to a new master's recipient. I received an encouraging reply to my letter signed with my initials, but when I walked in, I was told "We won't hire a woman." So I made the rounds of consulting offices most of whom said they would not hire a woman. However, I finally got a job with a consultant who was interested in ability and was put right to work designing a high-rise hospital. I had to move out of town and when I returned it was a constant process of last hired-first fired in the chronically uncertain construction industry and generally at lower pay than men doing the same or even less responsible work. I finally went to work for the state in 1956. There are many professional women of my generation in public employment because civil service is an equal opprtunity employer, at least at the journeyman level.

As soon as I was eligible in 1953 I applied for membership in the Structural Engineers Association of Northern California. It took about a year and some changes in the board membership before I, the first woman applicant, was admitted although the by-laws said nothing about sex being a qualification for membership. I was later told by a board member that my application ruined their meetings for several months. When I showed up at the Engineers' Club for my first lunchtime committee meeting, a waitress informed us that women were not allowed at lunch and so the whole committee had to move. This restriction was just changed about three years ago! The change is due to the activist feminists who pushed for the lifting of restrictions at all segregated clubs.

Obviously, my biggest problems have been men and their attitudes and being alone. However, I have been fairly treated at the state and since our clientele in the past, the engineers and architects who design schools, have been limited in number, they got to know me and my work and we got along fine. When I have been on field assignments there has been no difficulty with the contractors or the workmen because I carry the full authority which is granted to our agency by law, namely, that violation of the Field Act is a felony. Because I have been involved in outside organizations and activities which have provided helpful contacts for our office and because I have been willingto take on extra duties, I am being given greater responsibilities.

For the past year I have been assistant office engineer, the first line supervisor of ten male structural engineers and also the first person to respond to questions from our clients. Since we have only been regulating hospital construction since 1973, there are new engineers and architects for me to deal with. Many is the time that a caller has told me he wants to talk to an engineer. One of the things I am having to learn is to deflect anger. The people with whom I deal often are irritated at the State, they are angry at the regulations, they resent being told that they have made errors--and the last straw is that they must deal with a woman. I have to keep reminding myself not to take their hostility personally. Of course there are the lesser annoyances--ladies events at conventions and sexist advertising in trade journals.

It is very important for all of us to be supportive of each other and helpful and encouraging to other women, not only to the ones who are just starting out but also to those who apparently have succeeded. We are so few in number and therefore so vulnerable that there is no room for petty infighting or "Queen Bee" attitudes. I believe that we are all indebted to the activist feminists who have pushed for sex to be included in the civil rights and equality laws and it is important that we all take an active part in maintaining the gains that have been made and pushing for true equality of opportunity.

Career conferences for young women should be earlier than the junior and senior high school years. By then it is too late for them to take the whole sequence of math and science courses which are prerequisite to the freshman college requirements and moreover they have been turned off from those subjects. It is often hard for employed people to take time off during a work day to visit a school and moreover, small children cannot be talked to and have their curiosity piqued; many of us in the Professions do not have the knack of how to interest children in a classroom setting. I would strongly urge that some of the enrichment programs be directed toward field trips for the elementary and particularly the primary grade girls to the places where women work in non-traditional occupations. Take them to the UC Medical Center where there are many women with post-doctorates doing research as well as women physicians; take them to an engineering or an architectural office and to a construction site, to a courtroom where a woman attorney is pleading a case, to a woman in a veterinarian hospital. The organizations of professional women are happy to help.

A very important point is how to answer the cries of "reverse discrimination". Remember that because of the constant discouragement of women at all levels, particularly in mathematics and science, the ones who survive are probably the best qualified whereas the group of men with whom these women are competing includes those of mediocre ability; therefore if qualified women are considered just on ability, no reverse discrimination can possibly occur.

Catherine Bird, author of Born Female enunciated a woman's version of the Peter Principle: "Women should be allowed to advance in corporate management because women have a right to rise to their level of incompetence the same as do men. No one knows, actually, what most women's level of incompetence is, really, but it's right there, lurking in every one of us." Let us hope that in the not too distant future, there will be enough women at high levels for us, too, to follow the Peter Principle.

Elizabeth Scott – Panelist
Mathematician, Professor, Statistics
University of California, Berkeley

Elizabeth L. Scott

Professor, Statistics Department,
University of California, Berkeley

I'm an old timer. When I went to college it was the end of the depression and employment prospects were dim, no matter what. I studied what interested me, especially astronomy and art. My family expected all four of us to go to college and one reason my parents had moved to Berkeley was so that we could attend a good university at low cost. My horizon then was vague; I knew that art and astronomy existed but I had no real contact with them even though my mother's oldest sister had a doctorate in astronomy and I had heard stories of her activities and problems. But that was long ago and she was far away, no longer active in astronomy. I soon learned that women were not allowed to use the large telescopes at the Mt. Wilson and Palomar Observatories (and no woman has yet used the 200-inch telescope), not because special size or strength are needed to handle large telescopes but just because of prejudice. Many persons told me of the problems and even advised me not to obtain a doctorate in astronomy, always with the best of intentions. The faculty at Berkeley were always most helpful and I liked astronomy more and more as I turned to theoretical astronomy and then to statistical astronomy. With the outbreak of World War II, I was studying and working in statistics and gradually became a statistician. But my interest in astronomy continues and I have published some 20 papers in astronomy, most of them with a statistical flavor and many of them joint with astronomers, especially with Professor C. D. Shane, formerly director of the University's Lick Observatory where women astronomers do have fair access to all telescopes.

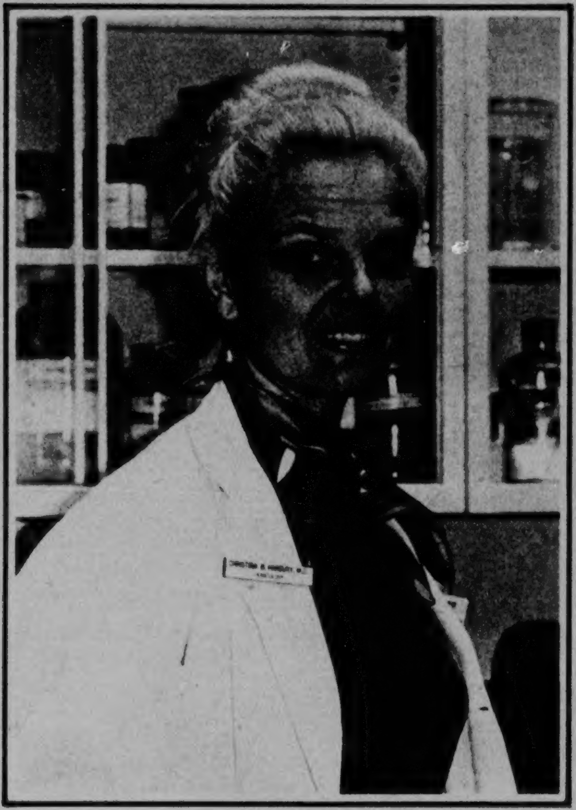
Statistics has the wonderful advantage, or perhaps distracting disadvantage, that it overlaps many fields, so that there are many different problems to work on. Perhaps the long tradition of women to study problems that are interesting and important from their own point of view without worrying about the personal gain attached (since there has rarely been any such gain for women) leads women not to be afraid of working on problems that are controversial. Certainly, I seem to have more than my share: carcinogenesis and other cancer problems, weather modification, and affirmative action, to name a few. I try to find the facts and have lots of fun in the process!

Commercial operators will tell you that cloud seeding, such as putting a little silver iodide smoke into a cloud, allows them to modify the weather as they wish: to decrease hail in Colorado, to increase rainfall in Arizona, , and so forth. The facts are that every single experiment in the United States has given negative results: more hail and bigger hail stones instead of less, less rain instead of more and not just in the target area -- the decrease stretches more than a hundred miles downwind. We have been active in the design and analysis of these weather modification experiments for many years now and have learned a lot but the problems are from solved.

As you know, affirmative action is a controversial subject. In the better paying positions there are few women, and the women who are employed have lower salary than men in similar positions. What are the reasons for the apparent inequities? Is it that women have less education, less experience and tend to go into lower-paying fields? There are such differences but they explain only part of the discrepencies. We have been studying the factors that affect salary, using the data collected by the Carnegie

Commission on Higher Education and the American Council on Education. We first estimated the salary of faculty in each field at the various kinds of universities and colleges using as predictors some 25 variables: highest degree, year of highest degree, age, number of years in academe, amount of teaching, preference for teaching over research, number of papers published, number of books published, marital status, number of children, and so forth including sex. We found that sex was always very important; women tend to be paid on the average $1800 less per year than men with the same attributes. The discrepency is even higher in the more prestigious universities and in the physical and biological sciences, just in those places where women are scarcest. We also can estimate the salaries separately for men and for women; the factors that are important will not be the same and it is interesting to see where the differences are. We find that systematically women tend to enter at a lower salary and to go up less often and at a slower rate. For each woman we can estimate what her salary would have been if she were a white male with the same output, same training. -- same attributes in all respects except sex. We can compare the estimate with what she actually receives to find how much she is underpaid. The outcomes are startling! Women have a long way to go to attain equity, and many persons need to pay attention to the underlying problems.

I have touched on some of the things that make statistics interesting to me without mentioning the problems in theory and the most interesting part, the contacts with students through teaching and research. As in other fields of science, the topics we study and the roles we can take are quite diversified. The preparation needed is also variable, certainly some mathematics, probability and statistics, and also some fundamental courses in the fields where you may wish to use statistics, such as biology, economics, nutrition, political science, And when you find subjects that you like, then really study them!



Christina Harbury – Panelist
M.D., Professor of Hematology
Stanford Medical School

Dr. Christina Harbury
Assistant Professor of Hematology
Stanford University Medical Center

WE WERE ASKED TO RESPOND TO THREE QUESTIONS. THE FIRST ONE IS, WHAT INFLUENCED OUR CAREER CHOICE. AFTER SOME SERIOUS THINKING, I HAVE DECIDED THAT THE MOST IMPORTANT VARIABLE WAS THE FACT THAT I HAD NO CONSTRAINTS PUT ON ME WITH RESPECT TO WHAT I WAS EXPECTED TO DO, OR WHAT I WAS THOUGHT ABLE TO DO. HOWEVER, I WAS EXPECTED TO HAVE A CAREER JUST LIKE MY BROTHER, AND I WAS EXPECTED TO HAVE A FAMILY JUST LIKE MY BROTHER. BOTH WERE NORMAL PARTS OF LIFE, AND WERE NOT VIEWED AS INCOMPATIBLE.

FROM EARLY CHILDHOOD, ALL SWEDISH CHILDREN ARE ASKED WHAT THEY WILL DO WHEN THEY GROW UP, AND THE ANSWERS ARE SERIOUSLY CONSIDERED. AT ONE TIME I WANTED TO RUN A BIG FARM. NO ONE EVER DOUBTED MY ABILITY TO DO THAT, BUT THEY ASKED ME WHERE I WOULD GET THE MONEY TO BUY AND OPERATE SUCH A FARM. THAT, OF COURSE, WAS A REALISTIC CONSTRAINT. ANOTHER VERY REAL AND SUPPORTIVE FACT WAS THAT THE FAMILY HAD BUDGETED FOR THE EDUCATION OF BOTH MY BROTHER AND ME, AND WE WERE ASSURED THAT LOANS, SHOULD THEY BE NEEDED, WOULD BE GUARANTEED BY THE FAMILY. THUS, I FEEL THAT THE MOST IMPORTANT GROUNDWORK FOR A CAREER CHOICE CAME FROM MY CHILDHOOD: I WAS EXPECTED TO HAVE A CAREER, THERE WERE NO CONSTRAINTS ON MY CAREER CHOICE EXCEPT FOR REALISTIC ONES (WHICH APPLY EQUALLY TO BOYS AND GIRLS), AND THERE WAS VISIBLE PLANNING TO HELP ME AND BACK ME WITH THE EXPENSE OF HIGHER EDUCATION. BOTH MY BROTHER AND I WERE STERNLY AND OPENLY JUDGED ON OUR ABILITIES, WHICH GAVE US A VERY REALISTIC IDEA OF WHAT WE COULD DO. FINALLY, WE WERE BOTH EXPECTED TO HAVE A FAMILY. I WAS NEVER TOLD I HAD TO BE A PERFECT HOUSEKEEPER, BUT GOOD COOKING WAS CLEARLY APPRECIATED. I LEARNED TO COOK EARLY, AND TO DATE I ENJOY BOTH COOKING AND EATING.

I HAVE POINTED OUT THESE DETAILS BECAUSE I SUSPECT THAT THE GROUNDWORK FOR WHAT AN INDIVIDUAL EXPECTS OF HIM OR HERSELF IS LAID EARLY IN CHILDHOOD. MY TWO DAUGHTERS COME HOME WITH STATEMENTS LIKE: "THE KIDS AT SCHOOL SAY THAT GIRLS CAN'T DO MATH," OR "OUR TEACHER SAYS GIRLS SHOULD PICK FEMININE OCCUPATIONS" ETC.

MY IMPRESSION IS THAT MOST AMERICAN GIRLS ARE BROUGHT UP WITH THE EXPECTATION THAT THEY WILL MARRY, HAVE CHILDREN, AND BE IDEAL MOTHERS. THEY MAY DABBLE IN DIFFERENT AREAS, BUT TO HAVE A SERIOUS PROFESSION IS THOUGHT TO EXCLUDE HAVING A FAMILY, WHICH IS THE MAJOR AIM SET FOR THEM. AS FAR AS I CAN SEE, THE SOCIETY ITSELF HAS VERY FEW LEGAL LIMITS ON WHAT WOMEN CAN DO. THE MOST SERIOUS LIMITATION DOES APPEAR TO BE THE LIMITED ROLE MODEL TAUGHT TO THE CHILD, AND ENFORCED BY THE GROWN WOMEN.

RETURNING TO THE SPECIFIC QUESTION OF WHAT INFLUENCED MY CHOICE OF CAREER: I DO NOT THINK MY REASONS FOR CHOOSING A PARTICULAR PATH WERE DIFFERENT FROM THOSE OF MY BROTHER. I HAVE ALWAYS ENJOYED PROBLEM SOLVING, WITH THE LIMITATION THAT I LIKE THE RESULTS TO BE USEFUL IN SOME WAY. IN FACT, IT IS PROBABLY FUNDAMENTAL TO MY CAREER CHOICE THAT I WANTED TO LEAD A LIFE AT ONCE INTELLECTUALLY SATISFYING AND USEFUL. MY MOTHER WAS A PHYSICIAN, MY FATHER A MATHEMATICIAN, AND MY STEPMOTHER A CHEMIST. ONE UNCLE WAS A JUDGE, ANOTHER UNCLE A PROFESSOR OF FRENCH. THESE WERE THE PROFESSIONS I WAS FAMILIAR WITH. I ENJOYED MATHEMATICS, BUT I KNEW I DID NOT HAVE THE GIFT THAT MY FATHER HAD. THUS I TURNED TOWARD THE PROBLEM SOLVING CHALLENGE OF RESEARCH AND MEDICINE, AND THERE I HAD A HARD TIME MAKING UP MY MIND. THE FAMILY STOOD UNITED; NO ONE WANTED ME TO GO INTO MEDICINE. UNDAUNTED, I WENT TO MEDICAL SCHOOL BECAUSE I KNEW I WOULD ENJOY PATIENT CARE AND THE PROBLEM SOLVING INHERENT IN DIFFERENTIAL DIAGNOSIS. DURING HOUSE STAFF TRAINING, A VERY INCONVENIENT AND UNANTICIPATED NEED

SURFACED IN ME. THERE WAS NO WAY AROUND IT, I WANTED TO DO RESEARCH. IN REALISTIC TERMS, THIS MEANT I WOULD STILL NOT EARN ENOUGH MONEY TO PAY THE BABYSITTER FOR YEARS TO COME. IN THE LONG TERM, IT MEANT I HAD CHOSEN A CAREER WITH A FORMIDABLE AMOUNT OF WORK: TEACHING, RESEARCH, AND PATIENT CARE. SINCE I DO NOT MIND WORKING HARD, AND SINCE I AM NOT TIMID, THIS DID NOT PUT ME OFF. I HAD HAD THE AUDACITY TO HAVE FOUR CHILDREN DURING MEDICAL SCHOOL, AND I FIGURED I HAD THE COURAGE TO DO THOSE THINGS WHICH I HAD AN ENORMOUS DESIRE AND DRIVE TO DO.

AT THE PRESENT TIME, I AM WORKING HARD BUT LIVING AMID AN EMBARRASSMENT OF RICHES. I AM CHALLENGED AND SATISFIED IN ALL THE ASPECTS OF MY WORK, AND WE HAVE A HAPPY HOME LIFE. OUR FOUR CHILDREN ARE HAPPY, BOUNCY AND NORMAL KIDS.

I WOULD LIKE NOW TO TURN TO THE SECOND AND THIRD QUESTIONS: "WHAT ARE YOUR GREATEST CHALLENGES, AND WHAT ARE YOUR GREATEST PROBLEMS." MY GREATEST CHALLENGES CLEARLY LIE WITHIN MY RESEARCH WORK, AND OF COURSE THAT IS WHY I AM THERE. PRACTICAL CHALLENGES, HOWEVER, ARE SEVERAL; AND THEY ARE OF GENERAL INTEREST. A GOOD ARRANGEMENT FOR HELP WITH CHILDCARE IS A REAL PROBLEM NOT ONLY BECAUSE GOOD HELP IS DIFFICULT TO FIND, BUT ALSO BECAUSE IT IS EXPENSIVE. I DO NOT THINK YOU CAN EXPECT ANYONE OF INTELLIGENCE AND ABILITY TO COME TO YOUR HOME OR TO A CHILD CARE CENTER TO HELP CARE FOR YOUR CHILDREN UNLESS THEY COMMAND RESPECT AND A GOOD SALARY. THEREFORE, IF YOU WORK, YOU FACE AN ECONOMIC PROBLEM. THE PROFESSIONAL WOMAN MARRIED TO A PROFESSIONAL MAN, AND IN FACT ANY MARRIED WORKING WOMAN IS UNFAIRLY TAXED FOR HER EFFORTS. ASSUME YOU EARN $20,000 PER YEAR AND YOU WERE UNMARRIED; THEN YOU WOULD BE IN THE 38 PERCENT TAX BRACKET. IF YOU ARE MARRIED AND YOU FILE A SEPARATE RETURN, THEN THE TAX BRACKET IS 48 PERCENT. THE MAN WITH A WORKING WIFE IS, OF COURSE, ALSO FACED WITH THE SAME HIGHER TAX RATE. THIS

I BELIEVE TO BE DISCRIMINATION AGAINST MARRIED WOMEN (UNCONSTITUTIONAL DISCRIMINATION, ONCE THE EQUAL RIGHTS AMENDMENT PASSES). IN PRACTICE, IT IS A REALISTIC DETERRENT TO WOMEN WORKING. THE CHILD CARE DEDUCTION IS ONLY ALLOWED IF THE COMBINED INCOME IS BELOW $18,000, AND THAT RARELY APPLIES WHEN TWO PEOPLE WORK.

I DO NOT BELIEVE THE WAY TO PROVIDE ADEQUATE HELP WITH CHILD CARE DURING WORKING HOURS IS TO BEG PRIVATE FOUNDATIONS OR THE GOVERNMENT TO FUND THESE VENTURES. THE WAY TO SOLVE THE PROBLEM IS TO REMOVE THE EXCESSIVELY HEAVY TAX BURDEN PUT ON THE MARRIED WOMAN. THIS WILL ALLOW HER TO USE THE MONEY SHE FAIRLY EARNS TO PROVIDE QUALITY CARE FOR HER CHILDREN.

TO SUMMARIZE, I BELIEVE THE GREATEST DETERRENT TO CAREER PARTICIPATION BY WOMEN IS THE IMAGE GIRLS AND WOMEN HAVE OF THEMSELVES. THE PROBLEM OF TAX DISCRIMINATION WILL, I BELIEVE, BE RESOLVED IN THE COURTS UPON PASSAGE OF THE EQUAL RIGHTS AMENDMENT.

Elizabeth Rauscher – Panelist
Theoretical Nuclear Physicist
Lawrence Berkeley Laboratory

ELIZABETH A. RAUSCHER

Theoretical Nuclear Physics
Lawrence Berkeley Laboratory/University of Calif.,Berkeley

I. MOTIVATION TO BECOME A SCIENTIST:

I am curious about how things work. I want to comprehend the nature and structure of the universe. I have an insatiable desire to know, to understand the origin and meaning of the cosmos and the meaning of life.

I can remember that at the age of 5 years old, we lived in the country and being surrounded by plants and animals, I studied them. I decided I would spend my life studying nature, that is to be a scientist.

I remember at age nine deciding that I would try to understand the macro-cosmos or universe or the micro-cosmos or domain of atomic physics, or both and then perhaps everything in between! The physical universe is much more comprehensible, it seems to me, than the complex nature of cognitive processes although equally fascinating. I chose to study the physical sciences. More is known about them than, say psychology but they are basically less complex.

II. GREATEST CHALLENGE OR TRIUMPH:

I think that one of the most exciting things one can experience is the creative process, whether it is the creation of a painting, a poem or the creation of a new idea about the way the universe works.

As I said before, I attempted to decide whether to study the macro or micro-domain, well I decided to study both! I have been working in the field of Einstein's general relativity and also the foundations of the quantum theory and in nuclear physics. Einstein's field equations describe how the gravitational field of a mass body curves space. With this theory we can describe cosmological phenomena and gravitation in general terms. In the micro (atomic) domain, there is the Heisenberg uncertainty principle which relates to the limits of information we can deduce from micro phenomena. I asked myself how can we relate these two ideas. How can we bring an understanding of the micro and macro cosmos together: I developed a set of geometrical constraints and have demonstrated how they represent a model which unified general relativity and quantum mechanics.

An important aspect of this theory is the quantity which was derived in 1967 and called the quantized force. At lunch in the Lawrence Berkeley Laboratory cafeteria, early in 1968, overlooking Berkeley, I realized how to use my new force and other terms to unify general relativity and quantum theory! At many points along the way in my research after many hours of work, comes that exciting insight, that thrill of "knowingness." The adventure of search and discovery of how nature works is a continuing process. Do we discover or create ideas? Both I think, but in theoretical research, we create ideas of how nature works and these are tested by observations in the laboratory.

Finding a degree of understanding of something is most thrilling and rewarding and is greatly satisfying and getting the research work written up and published and communicating with scientists all over the world is most rewarding! There is much excitement in communication with researchers all over the world with people in your field of research. I published a number of papers related to this work and really enjoyed the very positive response and correspondence from people in India, Russia, South America, Europe, Japan, U.S.A. and many other places. Some researchers have been corresponding for years and it is pleasant to meet these people at meetings or our laboratory.

There are many years of perseverance and dedication between a flash of an idea and the day you go into a library and look at your paper in a journal! There is a sense of creation and communication. Is then the scientist not so different from the artist? We create pictures or models of how the world works!

I have been invited to present talks, edit books, write chapters for books on my work and received honorary recognition. I have exchanged ideas and worked with many colleagues; an exchange which has been most stimulating and rewarding.

III. GREATEST PROBLEMS:

I must say that my greatest problems revolve around prejudice against women in science. This situation has not been just recent or temporary but has been with me along my path of study and in my career as a scientist. Along the way I have received much discouragement but, of course, also encouragement. Here are some cases at point:
1) As a junior in high school, I was told more than once that women can't make a career in science. One example of this was when I was 14 years old, I, with my parents, visited the Lawrence Berkeley Laboratory. The then assistant director got my folks aside and "kindly" said, discourage her from a science career as women are not accepted in science.
2) I must really say that I was not fully cognizant of the prejudice against women. Prejudice seemed particularly prevalent in the undergraduate university laboratories but less so in the lecture classes. In one undergraduate physics laboratory, as I would go to the store room for more equipment, male students along with the teaching assistant's knowledge and consent would undo my experimental apparatus. I had to keep close watch to prevent sabotage. I also let it be known I knew what was going on. Nothing more was done to my equipment. In all my undergraduate physics laboratories at the University of California, Berkeley, I was the only woman. If lab partners were chosen, male students would not pair off with a woman. In chemistry, where there were more women in the laboratories there was much more camaraderie and acceptance of women students.

In the big lecture courses, for example, I would be the one woman out of 200-300 students and readily identifiable! Most lectures seemed fair and in math, physics and chemistry courses where I received the top grade, I was readily congratulated.

3) In one junior level mechanics course though, again a class in which I was the only woman student, the professor told me not to attend his office hours as he could not stand women scientists. I taught this same course years later!
4) In a graduate seminar on S-matrix theory, again I was the only woman. The professor launched into a tirade about the stupidity of women, saying their brains were smaller than those of men. After about twenty minutes, I said in a loud voice, "but you use only 30% of your brain anyway"--not a logical answer but it shut him up!

Let me add though that I had many excellent and reasonable professors. Some have been most helpful and encouraging.
5) In applying for jobs in 1966 and 1967 at state colleges two examples come to mind. One at which the physics department was interested in hiring me but the dean of the college specifically said there were no women on the physical science faculty! Another case is the usual, you give a department talk, they show you around and at the end of the day you sit down with the physics faculty to discuss available positions. One interviewer said, "Well, we had a woman on the faculty and she didn't work out, so we shouldn't hire another woman." (I thought does this imply that if a man doesn't work out, you shouldn't hire another one of them?)

6) Well, I could give other examples. By this time the message was loud and clear. Particularly in the academic arena the "no" sign is out.

An article in the San Francisco Chronicle, a couple of weeks back, quotes a U.S. Office of Education study of women on faculties in U.S. colleges and universities. Women have been losing in salary and rank since the 1930's for example the salary raise for women in 1974 was 5.8% and for men 6.3% increasing again the salary differential.

Women are making some headway in law enforcement, in the military and as lawyers but not in science careers. But there are some bright spots; where as in 1958 I sat in many an all-male freshman physics or math class, now there is a definite increase in the number of women in undergraduate physics classes, by a few percent and increasing each year. This will hopefully challenge the system which must realize the great unutilized potential of these fine young women's minds! More and more women are being challenged by the excitement of science and are in turn challenging the system and entering the domain of science research and science education at all levels.

IV. IN CONCLUSION:

I see optimistic seeds of change--for example, today's symposium. No matter how discriminatory and unfair the present system is, I believe things will change through our collective efforts. When women become economically and influentially equal to their male colleagues, and no longer have to "prove" ourselves, than we can get on about the task of "doing" science.

Not only can women be good at being scientists, but we can be excellent; in fact, st in the field! There is nothing wrong with being best!

I find science a most meaningful and exciting career. I enjoy the stimulus and dedication of research and enjoy the interactions of students.

Being a scientist is exciting and fun and I also believe that scientific research has significant and important impact on our society. The use of the methodology of science will help us to rectify some of the ills in our society.

Ruth N. Havemeyer – Panelist
Pharmacist, Product Development Manager
Syntex Corporation

RUTH N. HAVEMEYER
Product Development Manager
Syntex Corporation

My background is in pharmacy, both undergraduate and graduate. I was a laboratory scientist before moving into a management position, and I am now a research project manager at Syntex, a pharmaceutical company. Since receiving my graduate degree I have always worked in industry, and in that respect I differ from our other panelists. When I was doing my graduate research and trying to decide which career path to choose, I felt that there were three options: teaching, university research, or industrial research. Teaching didn't appeal to me. As I looked around, it seemed that those associated with universities spent a great deal of time writing grant proposals or in other ways worrying about funding their research. Consequently, I was leaning toward industry because I felt I would actually spend more time at bench research and that was what I wanted to do. I think what finally pushed me to industry was a remark by my major professor. He said in effect "you might as well forget about industry. They don't hire women for research". Perhaps he was being kind and trying to save me from disappointment, but I was orn'ry enough to decide I was going to prove him wrong. I admit it was frustrating to have interviews, be listened to politely, and then be told that they couldn't hire women for research. When pressed for a reason the usual answers were "you would be uncomfortable working only with men" (even though at the time I was the only woman student in a graduate department of 90), "the men won't accept you", or "the wives wouldn't like it if they knew their husbands were working with a woman in the lab"! You can think of many replies to that last one, but of course I didn't in those days. But at any rate, I was offered a job by a pharmaceutical company (Squibb) and I have been very happy in the industrial environment.

I know that to many scientists industrial research is a dirty word and those so employed are thought to have sold their souls for the profit motive. I also think that most teachers and counselors do not know as much about industry as they do academia - after all, industry is very large and does vary so much - and, therefore, they tend not to suggest it to their students. In addition, there are also some detractors that contend that in industry you cannot do the research you want or research that is interesting. That just is not so. In the first place, you may be hired because of your previous research or expertise in a certain field. Obviously, you would continue in that research field. Secondly, with the variety of projects carried out in any research firm, it is hard to imagine that a scientist - a person with a natural curiosity - would not find a project that is interesting. I assure you that research in industry is as challenging, rewarding, and frustrating as academic research or teaching. Your research can lead to publications and patents, just as it can in an academic environment. Also, to the best of my knowledge, industry offers equal pay to men and women.

I would like to take the scientific disciplines of each of our panelists and show how they would fit into industry. Remember that I am most familiar with the pharmaceutical industry and, therefore, I will fit them into that environment.

BIOLOGIST - a person with this training might study the basic activity of drugs in animals; or the interaction between drugs and various body tissues or fluids; or develop methods of analyzing chemicals in body tissues; or perhaps do enzyme studies.

CHEMIST - Depending upon the particular area of chemistry, would perhaps synthesize new compounds; develop analytical methods, either chemical or instrumental; investigate the chemistry of degradation of a compound in order to prevent its degradation and make it more stable.

ENGINEER - A structural engineer might design new buildings or renovate existing ones; a chemical engineer might be involved in chemical processing or scale-up operations; finding a better way to make large quantities; after all, the methods used to make 50 mg in the laboratory are quite different from those required to make 50 kg in production, and a chemical engineer is most valuable here.

MATHEMATICIAN OR STATISTICIAN - I think this would be one of the most interesting areas to be in; such a person may help other scientists to design their experiments so that they have sufficient data to enable them to draw valid conclusions; you would be surprised at how many experiments are poorly designed and therefore must be repeated; the help of a mathematician or statistician is invaluable here; a biostatistician would analyze the results of clinical studies to determine whether or not a drug is active. The FDA does not look kindly upon patient testimonial to prove that a new compound has activity; the FDA likes data.

PHYSICIAN - Would design and monitor clinical trials; conduct clinical trials; be one of the prime people who interacts with the FDA in representing a pharmaceutical company.

PHYSICIST - Nuclear physicist: I confess I can't think of where a nuclear physicist would fit into the pharmaceutical industry, but certainly there would be many opportunities in other industries. A non-nuclear physicist might design and develop medical equipment such as is done at one of our subsidiaries, or might be involved in research in electron microscopy or crystallography.

I have touched only on those fields represented by our panelists today. But mention any scientific discipline and you will find it is utilized in industry. And so I urge you, in your career planning, or when counseling students, to keep the options open. Consider industrial employment as well as academic or government employment. Industry needs scientists. Industry needs women scientists.

Discussion groups.

1. Cooperative Programs in Science and Engineering at Stanford University

Mary Lou Allen, Asst. Director, Instructional Television Network
Stanford University

ABSTRACT

A description of three cooperative programs in engineering and science at Stanford University is given with the greatest emphasis on the Honors Cooperative Program initiated by the School of Engineering.

Perspectives of women in the Honors Cooperative Program are discussed in the context of an informal questionnaire distributed to the total population of women in the program during the last three years. The focus of the questionnaire falls on (1) the search for similar characteristics of women in Engineering (background, age, reason for becoming an engineer) and (2) the determination of motivational factors for enrolling in the Honors Cooperative Program. The data analyzed from the questionnaire showed that more than half the fathers are professional and at least half of those are in science. In most cases, the major reason for becoming an engineer was an aptitude and interest in science and math rather than monetary or other factors. The motivational factors surrounding participation in the Honors Cooperative Program were the financial advantages and encouragement from direct supervisors.

The percentage of women in the two cooperative programs (Honors Cooperative Program and Dual Degree) is discussed in light of current affirmative action efforts by industry and Stanford University.

STANFORD'S COOPERATIVE PROGRAMS IN ENGINEERING AND SCIENCE

THE HONORS COOPERATIVE PROGRAM

The largest cooperative program in engineering and science between Stanford University and industry is the Honors Cooperative Program begun in 1953 by the School of Engineering. Its primary objective is to promote communication and interaction between the theoretical and applied aspects of each institution; to have each supply valuable perspectives and resources to the other. Initially, there were about 20 company members located from San Francisco to San Jose.

If an employee from a member firm became interested in pursuing an advanced degree at Stanford, he or she would seek approval from the main supervisor and then apply to Stanford through the normal graduate admission procedure. Once admitted, the student would drive to campus to attend classes virtually half-time. The company granted time off and, in most cases, paid at least partial tuition, book costs, etc. The same Stanford services and human resources available to the full-time, on campus student were also available to the Honors Coop student. The only negative factor when the program began was the time spent en route. For example, a student coming from San Jose could sometimes spend 2-3 hours a day traveling. The energy problems (commuting time, gasoline, fatigue) prompted the installation of an Instructional Television Fixed Service (ITFS) Network on the Stanford campus in 1968. The Federal Communication Commission has designated 28 channels for instructional television within the U.S., and Stanford has been given 4 of those. Companies that were members of the Honors Cooperative Program also became members of the Stanford Instructional Television

Network and installed receiving equipment and television sets.* The result is a tremendous savings in time and energy and a significant increase in participation. Stanford broadcasts between 45-50 graduate courses in all departments of engineering as well as math, computer science, physics, and statistics every quarter. Forty companies within a fifty mile radius of the campus subscribe to the Honors Coop - Stanford Instructional Television Network Program. A talkback option was designed using an FM radio signal which enables television students to press a button on a microphone and ask a question of the instructor in class.

The curriculum is designed to provide core courses, essential sequences, and a wide range of electives to fulfill requirements for Masters degrees in engineering.

Stanford presently offers two other student options to the television audience, the Non-registered Option and audit status. The Non-registered Option student can be one who already has an advanced degree but desires refresher courses with the rigor of examinations and a grade, or one who is not yet qualified to be admitted to Stanford's graduate program. In the latter case, the student may take a few courses to prove his or her ability.

A daily courier service to industry to insure prompt distribution and retrieval of class notes and exams is provided by the Network.

Most faculty are not only cooperative but generous with their time to off campus students. Students from industry either take examinations at work or come to campus if the instructor asks them to.

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*All except four became Network members. Now membership in the Honors Coop requires membership in the Network.

The Honors Cooperative Program has proven to be an effective vehicle for graduate education and a facilitator for research projects between Stanford and industry.

THE DUAL DEGREE PROGRAM

A second cooperative effort in engineering and science at Stanford is the Dual Degree Plan also originating from the School of Engineering. The interaction here is with liberal arts colleges (Claremont, Mills, Willamette, etc. See Table 2) who send students, after their third year, to Stanford for two full years in engineering. At the end of five years, the student receives a B.A. from the home school and a B.S. in engineering from Stanford.

The home college appoints a faculty member to coordinate business between the home college, the student, and Stanford. All applications and recommendations for students must pass through the coordinator. A student applies as a transfer to Stanford and is given special consideration if he or she has (1) a recommendation from the college coordinator, (2) a competitive grade point average, and (3) a satisfactory Scholastic Aptitude Test score. He or she is expected to have completed required humanities, writing, and social science courses at the home school and also calculus and a substantial program in science.

In the twenty year period from 1955-1975, the Dual Degree Program has had 156 participants from 8 colleges with 75% coming from Claremont College.

STANFORD PHYSICS AND COMMUNITY COLLEGE PHYSICS

The Physics Department at Stanford, through the support of the Center for Teaching and Learning, is enthusiastically pursuing plans for offering updating and renewal lectures for community college physics teachers. The three, one-day sessions currently planned for summer 1976 will take place at Stanford with lectures given by the Physics faculty.

If this pilot project is successful, the Physics Department hopes that further cooperative efforts with local community colleges could develop a program for a better understanding of science and its policy issues by the community.

WOMEN IN ENGINEERING COOPERATIVE PROGRAMS

An informal query was distributed to the 47 women, from 9 companies enrolled in the Honors Cooperative Program within the last three years (see appendix for full data on questionnaire). The primary reasons for the questionnaire were to (1) determine what characteristics these women might have in common and (2) examine motivating factors for their participation in the Honors Cooperative Program.

Although only about 45% of the questionnaires from 8 companies were returned, the responses yielded some interesting results. For example, the median age of the women is 24 (the youngest 22, the oldest 44) which shows that a substantial number of women have begun to study for a graduate degree during their first few years of work experience. Well over half the women have fathers who are professional and of those the majority are science-oriented. Slightly more than half their mothers are professional and less than half of those are in science. The majority of the siblings are professional and half of those are in scientific fields. Question three shows that an overwhelming majority of the women are in engineering because they have displayed an aptitude and preference for science and math. Only three were motivated specifically by financial reward.

Through personal interviews with several of these women and from the responses to question 9, the most common characteristic seems to be a high degree of independence, determination, and perseverance.

The second reason for the query was to examine motivational factors for participation in the Honors Coop Program. Responses to question 4 show the overriding reason for working and studying simultaneously is the distinct financial advantage. Not only does the student earn a good salary but, generally, the company pays full tuition and other costs. A good number of responses show that practical application of course work is a significant incentive to working and studying at the same time (questions 4 and 8b). The strong encouragement by either the direct supervisor and/or the company's policy is an essential factor for participation in the Honors Coop (question 6).

This last variable could be the most crucial in terms of discrimination because of sex. However, the questionnaires and personal interviews showed that these women were strongly encouraged to enroll in the program. The reason for the paltry percentages of women in the Honors Coop Program shown in Table 1 is not so much a reflection of discrimination against women already working in industry as it is a reflection of the absolute lack of women in engineering. Table 1 shows a significant rise from 4.2% to 7.4% between the academic years 1972-73 and 1973-74 and also from 7.4% to 10.1% between 1974-75 and 1975-76. What could account for these increases? One fairly probable reason is the development of affirmative action programs by engineering firms to recruit more qualified women. Clearly, one important incentive for working at a particular company is the chance to study (or, in some instances, to continue to study) for an advanced degree at Stanford through the Honors Coop Program. At the same time, industry looks to its neighboring universities to supply highly capable women engineers. The Stanford School of Engineering, for the past several years, has been making a concerted effort to attract and encourage women to pursue an engineering career.* The subsequent rise in undergraduate women in engineering could then account for the rise in Honors Coop women shown in Table 1. Unofficial figures show that in 1975-76 approximately 18% of the graduate students in engineering are women and when polled, 24% of the undergraduate women at Stanford expressed a desire to study engineering.

Until 1975 when Mills College joined the program, the Dual Degree Program described earlier had had only one woman participant in its entire history (see Table 2). Mills sent one woman in 1975 and as of Autumn 1977 three more women will be enrolled, one from Willamette and two from recently admitted Scripps College. The School of Engineering is presently negotiating with other womens' colleges to join the Dual Degree Plan.

Stanford is working to increase and publicize the opportunities for women in engineering. Hopefully, the upward trend indicated by the 10.1% in the Honors Coop Program and the addition of womens' colleges to the Dual Degree Program will continue and blossom into other opportunities.

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* "The Stanford School of Engineering . . . CONSIDER THE POSSIBILITY," August 1972, available through Dean of Engineering, Stanford University.

APPENDIX

QUESTIONNAIRE SENT TO HCP WOMEN

NAME ______________________ AGE 24 median

COMPANY ______________________

1. WHAT IS YOUR EDUCATIONAL BACKGROUND?

   a. PRIVATE SCHOOLS OF PUBLIC? private 6 public 13 no answer 2

   b. WHAT COLLEGE FOR UNDERGRADUATE?

2. WHAT ARE YOUR PARENTS' VOCATIONS, YOUR SIBLINGS'?

Father		Mother		Siblings	
Professional	15	Professional	7	Professional	11
Science	9	Science	3	Science	5
Non-professional	6	Non-professional	13	Non-professional	3

3. WHY DO YOU THINK YOU BECAME AN ENGINEER? CAN YOU IDENTIFY ANY SPECIFIC MOTIVATING FACTORS IN YOUR DEVELOPMENT?

Aptitude & preference for math & science	15
Marketable skill (financial reward)	3
Challenge	2
On the job training	1

4. WHY DID YOU CHOOSE TO WORK AND STUDY FOR AN ADVANCED DEGREE SIMULTANEOUSLY?

Financial advantage	12
Part of the job	3
Needed advanced training	2
Combined theory & practice	7
Less pressure	1

5. WHY DID YOU CHOOSE TO WORK FOR YOUR COMPANY? DID THE OPPORTUNITY TO STUDY AT STANFORD INFLUENCE YOUR CHOICE OF COMPANIES? YES · 9

Good reputation	8
Interesting job	9
Summer job led to permanent	2
No other offer	2

6. WHAT DID YOUR COMPANY DO TO ENCOURAGE (OR DISCOURAGE) YOUR PARTICIPATION IN THE HCP?

Encouraged			
Direct supervisor support	6	Discouraged	1
General company encouragement	9	Neither	1
Necessary condition of job	4		

7. HOW LONG HAVE YOU BEEN PARTICIPATING IN HCP? Average 1.5 years

8. WHAT DO YOU THINK OF THE HONORS COOP PROGRAM? IS IT EFFECTIVE ? WHAT RECOMMENDATIONS DO YOU HAVE?

Good practical application	7
Effective	17
Recommendations	
More courses televised	5
Lower level coop programs	1
More contact with fellow students	5
Better availability of TA's	2
More counseling	3

9. DO YOU THINK IT'S IMPORTANT FOR WOMEN TO BECOME MORE ACTIVE IN SCIENCE? YES 17
WHAT SUGGESTIONS WOULD YOU HAVE FOR A BEGINNING WOMAN ENGINEER?

Do not accept failure easily	3
Stay calm, self-confident	1
Stay committed	2
Take a lot of survey courses	5
A woman has to be sharper and more assertive than a man in the same position	2
Accept the fact that engineering is a lot of work	2
Get practical work experience	1

10. WHAT ARE YOUR CAREER PLANS? WILL YOU CONTINUE FOR A Ph.D. in the HCP?

ENGR'S DEGREE	3
Ph.D.	4
MBA	3
Work full time	8
No plans	3

TABLE 1

YEAR	HCP TOTAL	HCP WOMEN	# OF COMPANIES WITH WOMEN IN HCP	PERCENTAGE OF WOMEN IN HCP
1975-76	308	31	9	10.1%
1974-75	350	26	9	7.4%
1973-74	297	22	8	7.4%
1972-73	375	16	8	4.2%
1971-72	352	10	9	3.5%
1970-71	547	15	8	2.7%
1969-70	563	19	8	3.4%

TABL 2

STANFORD UNIVERSITY
School of Engineering

SOURCE OF DUAL-DEGREE PROGRAM GRADUATES

	Claremont	Willamette	Knox	Pacific Lutheran	Redlands	Whittier	Pepperdine	College of Idaho	Mills	TOTAL
1955		1								1
1956		2								2
1957										
1958	5	2	1							8
1959	1									1
1960	5	2								7
1961	4	1	1							6
1962	4	1	1	1						7
1963	5	2			2					9
1964	5				1					6
1965	9						1			10
1966	5					1				6
1967	14	1				1				16
1968	7									7
1969	9		1			1				11
1970	7					1				8
1971	5	2				2				9
1972	14									14
1973	5			1		3		2		11
1974	6					3				9
1975*	7			1					1	9
TOTAL	117	14	4	3	3	12	1	2	1	157

*Expected to graduate

2. EDUCATING COLLEGE WOMEN IN MATHEMATICS

A Report of an Action Program in Progress*

by Lenore Blum, Professor of Mathematics
Mills College, Oakland, Ca. 94613

As head of the mathematics and computer science department at Mills, a small liberal arts women's college,[1] for the past two years I have been directing the development of a comprehensive program aimed at increasing the mathematical and technical skills of women students in many fields. Our goal is to create an environment where it will be as natural for women to study mathematics as it has been for them to study the humanities and fine arts -- an environment where women increasingly can view careers that require mathematical expertise (in science, technology or the more technical areas of the social sciences) as exciting and viable opportunities. Our program has been funded in part by grants from the San Francisco Foundation and the IBM Corporation.

It is well known that, for a variety of reasons,[2] many young women cease their mathematical studies early, often before completing high school. They are provided little opportunity for successful reentry into the mathematics curriculum and are thus severely limited in their career possibilities -- even as they start college.[3] Whether these limitations are the result of poor teacher, parent or peer attitudes, role stereotyping, inadequate or even misleading counseling, negative experiences, or general "math anxiety,"[4] our philosophy is that the best way of overcoming these problems is by "doing it". Thus, a key feature of our program is to provide quick and easy access (both psychologically and actually) into the regular mathematics curriculum. Although our focus is on educating women and our milieu is a small women's college, we believe many of our ideas and methods are applicable to (and easily can be adapted to) a wide variety of learning situations.

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* This paper is based on a talk presented at the conference, "Educating Women for Science: A Continuous Spectrum," held at Mills College on April 24, 1976, and sponsored by the Center for Teaching and Learning, a Danforth supported office at Stanford University. It constitutes an update of a report published in the Newsletter of the Association for Women in Mathematics, May, 1975.

The multifaceted approach of our program incorporates a variety of components, including: (at the introductory level) stimulating student interest; designing goal-oriented entry level courses with a support structure of peer-taught workshops; (and at higher levels) designing interdisciplinary courses and modular course components stressing applications; encouraging active and meaningful student participation as peer teachers and as lecturers in the departmental seminar; providing early career experiences through internships (in cooperation with IBM and other companies); and providing dual degree options in liberal arts and engineering (in conjunction with the Stanford, U.C. Berkeley and Boston University Schools of Engineering). I will discuss some of these components in more detail.

Our program's initial project, undertaken in 1974, was designed to provide a basic grounding in mathematics with the immediate goal of getting students, no matter what their backgrounds, into a calculus sequence quickly. This project focused on:

(1) Stimulating student interest and motivation: A mini-brochure[5] describing the program and including self-placement quizzes was sent to all students. Apparently its positive, low-keyed nature

was effective. Virtually every student on campus knows about the program; a large percentage took the quizzes. In a well publicized and well attended weekly departmental seminar, invited speakers (principally women) have presented topics of general interest and provided career information, e.g. "Mathematics as the Critical Filter in the Job Market," "Careers in Computers," "Personality Characteristics of Women Scientists," "Mathematical Methods in Population Studies," "The Origins of the Universe," and "Women in Engineering."[6]

(2) Offering goal-directed courses that avoid the negative implications of remedial work: Many of the students we wanted to reach had only limited high school mathematics backgrounds. However, we felt that the idea of spending an inordinate amount of time in preparing for calculus would effectively deter them from entering the program. It was therefore crucial to design a course that would, in one semester, prepare a student directly for the calculus sequence -- no matter what her level of preparation. It has been our experience that the usual college algebra course was a dead end in this direction: it often merely repeated high school work in which students already had developed a history of negative attitudes; it was clearly remedial in nature and thus carried further negative implications; it included enormous amounts of material without managing to deal adequately with concepts (such as slopes, limits, continuity) which are fundamental to calculus.

Our approach was to present a streamlined course that dealt mainly with a systematic study of the elementary functions in the spirit of calculus. A main goal was to develop analytical and comparative techniques so that students could visualize the graphs of these functions.[7] At first, the students resisted and felt uncomfortable with this qualitative and conceptual approach.[8] However, within a few weeks, they were able to visualize a variety of functions and became fairly sophisticated in asking questions such as: Where does the function blow up? What happens in the limit? Is it periodic? Symmetric? How fast is it growing? At this point there was a dramatic change in student attitudes about course methods and about their own previous feelings of mathematical powerlessness. Apparently, giving students the tools to visualize algebraic symbols, and thus making them meaningful, is an effective method of "demystifying" mathematics.[9]

(3) Providing an extensive support structure of peer-taught workshops: It was clear that some pre-calculus students would need additional help in developing arithmetic and algebraic skills. We did not wish to include this sort of material in the main course for the reasons already outlined. Thus, pre-calculus workshops (small work sessions, taught by undergraduate teaching assistants under faculty supervision)[10] were designed in conjunction with the pre-calculus course to meet these needs. These workshops allowed a single course to accommodate a variety of student backgrounds and abilities. They also provided students with individual attention and immediate help and feedback in a supportive environment.[11]

The entry level mathematics project just described was carefully designed to overcome the anxieties about mathematics common among many women students. More importantly, it gave students the means to break from past patterns of failure or frustration by experiencing success in mathematics studies geared to their individual needs. The project has accomplished the very specific goal of preparing students with weak mathematics backgrounds for calculus and has given them a sophisticated grasp of some important mathematical concepts. However, it is not a panacea that will produce immediate agility with general problem solving or even computational skills. The newly acquired mathematical self confidence of these students can still be easily shaken. After all, they have just begun their mathematical training and typically do not have years of solid grounding and positive experiences behind them.

Thus, for example, it is clear that the pre-calculus course and the subsequent calculus sequence must be closely coordinated. It is crucial that the calculus instructor be aware of where these students are coming from, what they know, and what they don't know, in order to work out a smooth transition.[12] It also seems reasonable that support workshops be designed in conjunction with other beginning mathematics and science courses to give these students help when they need it and when their motivation is high. In this way they will be able to gain experience in using analytical and problem solving techniques in a variety of situations and then will be better able to abstract and transfer these skills for themselves.

The next stage of our comprehensive program focuses on increasing student options and potential at other levels. One aspect of this effort is to increase the applicability of the mathematics curriculum by developing interdisciplinary courses and by introducing applications components into each of our standard courses. For example, linear programming and constructive methods are included in our linear algebra course. In the fall of 1975, Jim Schwarz, a chemical engineer (given released time from Chevron Research Company) taught a course on Mathematical Modeling to 20 students representing 11 different major areas of study. Carol Lennox, Mills' Coordinator for Computer Activities, is developing a series of interdisciplinary projects with other departments, e.g. with sociology and psychology (using computers to do questionnaire and statistical analysis), and with economics (using computers to simulate various economic models). Fourteen students were enrolled in a January term course in Accounting and Computing. About half these students had had some accounting, the other half some computing. The students taught each other and by the end of the four weeks had written a payroll and inventory evaluation plan for a small company.

Another important aspect of our program is the provision of meaningful experiences that will help students develop the self-confidence and positive self-image needed to view many options as truly feasible. Thus, we have encouraged active student participation in a variety of ways. One way is through the peer teaching project. Another is through the departmental seminar where each of our majors presents at least two lectures on topics in mathematics or computer science.

Still another approach is through the intern program, which provides students with early career experience through supervised work in real world job situations (full-time during January term or summer, part-time during the regular academic year). This is particularly important for young women who often have had little or no opportunity for involvement with technical areas of the working world. Students who participate in this program develop a real sophistication and "know how", but more importantly, they acquire concrete knowledge that they can "do it". Clearly, this helps crystallize career plans and motivate further study.

Over the past two years, 14 Mills students have been interns at IBM, San Jose, under the supervision of Dr. Jean-Paul Jacob. These students have worked closely with researchers on a variety of projects that included: working on an interactive graphics program enabling San Jose firemen and policemen to solve management, scheduling, and routing problems; working on simulations of competitive market situations to determine long range outcomes; modeling chemical and ecological systems (leading to a paper by intern Janette Walker on "Numerical Integration of a Stochastic Model for the Volterra-Lotka Reaction," that will soon be published in the Journal of Mathematical Biology).[14] Other students have been engaged in internships at such firms as Data Dynamics (working on a satellite tracking problem) and the Bank of America (doing data processing).

Evaluation: One measure of the effectiveness of the program is the number of participating students. The following table gives some comparative enrollment figures for the year 1973-1974 (the year before the program began) and this year, 1975-1976. These figures show an increase that is significant given the stable total undergraduate student population of 850.

	1973-74	1975-76
Total enrollment in math & computer science courses	324	513 in regular courses (58% increase) plus 207 in workshops total: 720
Pre-Calculus	27	63 (133% increase)
# of students who began a calculus sequence	32 (fall) 25 (spring) 57 total	54 (fall) 42 (spring) 96 total (68% increase)
# of students who took an introductory computer course	43	64 (33% increase, plus several hundred who dropped in on computer workshops)

Our upper division courses, although typically small, also increased in enrollments. For example, Modern Algebra went from six students in 1973-74, to 13 this year.

During the past two years, about 40 students have participated in the workshop project as peer teachers; 24 students have presented at least one lecture in the departmental seminar; 14 students have participated in the IBM intern program and several more have worked in other internships. Intern sponsors have been generally enthusiastic and supportive of the program. For example, Dr. Jacob, who has supervised the interns at IBM, wrote that "the young women whom I have met through this program are undoubtedly the most intelligent and enthusiastic group of students I have met in my career."

At the start of our program we asked participating students to describe their past attitudes, influences and experiences with respect to mathematics. Typical comments were:

"Math has freaked me out since tenth grade."

"Generally, I've been afraid of math and been greatly influenced by the 'math mind,' convinced I was part of the vast majority that didn't have one."

"I never had problems keeping up with math until the end of the year in algebra. That freaked me out so I procrastinated a year before taking geometry. I got so lost there, I vowed never to take math again. So here I am!"

Later we asked students who participated in workshops to evaluate them:

"I did not like math at all and did very poorly until this course. The workshop was so helpful in understanding the precalculus work that I plan to go on in math."

"Great! I only wish this would have been available when I was a freshman/sophomore."

"Very innovative and needed idea. Directly related to my needs. Thank you."

The success of the program probably depends on a variety of factors. Peer teaching with its positive effects resulting from unpressured settings and credible role-models, certainly is important. The enormous amount of energy expended is certainly a significant factor. But the key features seem to be the goal orientation of the program and the attempt to meet fairly immediate student needs, often in the students' own terms.

Of course, evaluation with respect to long term and sustained effects will be needed. In this regard, we have begun a study to determine changes in career aspirations and long range career and employment patterns. Preliminary indications have been encouraging. For example, although science students at Mills often have gone on to graduate schools, medical schools, or scientific laboratories, there have been in the past only isolated reports of graduates entering engineering-related fields. This pattern appears to be changing. Since the program began, four students have been accepted to engineering schools as undergraduate dual degree candidates and three more as graduate students. Two junior students are being employed as engineering trainees this summer (at U.S. Steel) in preparation for regular jobs there when they graduate. Three Mills graduates have entered engineering-related jobs in industry (with Lockheed, General Electric, and U.S. Steel).

NOTES

(1) Mills College has a student body of about 1000, including 850 undergraduate and 150 graduate students. More than one third of the students are third world and about one fifth are reentering women, older than the typical college student. Traditionally, Mills has been well known for its curriculum in the humanities and fine arts. In recent years, students have shown much interest in the sciences and mathematics as well, and the College has developed a full undergraduate degree program in mathematics and computer science. A campus computer center, with a mini-computer and time-shared terminals to Stanford and the Lawrence Hall of Science, serves students and faculty from all sectors of the academic community.

(2) See e.g.
Sanford M. Dornbusch, "To Try or Not to Try," The Stanford Magazine, Vol. 2, No. 2, 1974.

John Ernest, et al., "Mathematics and Sex," Department of Mathematics, U.C. Santa Barbara, to appear in The American Mathematical Monthly, Fall, 1976.

Else Hoyrup, "Women and Mathematics, Physics and Technology?," AWM Newsletters, 1974-1975.

Lynn M. Osen, "The Feminine Math-tique," KNOW, INC.

(3) For example, Lucy Sells pointed out in her pilot study of admissions applications of Berkeley freshmen for fall 1972, that "while 57% of the boys had taken four years of high school mathematics..., only 8% of the girls had done so. The four years of high school mathematics sequence is required for admission to Mathematics 1A (Calculus) at Berkeley, which in turn is required for majors in every undergraduate field except the traditionally female, and hence, lower paying fields of humanities, social sciences, librarianship, social welfare, and education." (See Lucy Sells, "High School Mathematics as the Critical Filter in the Job Market," Proceedings of the Conference on Minority Education at the University of California, Berkeley, May, 1973.)

(4) See e.g.
Mitchell Lazarus, "Mathophobia: Some Personal Speculations," The Principal, February, 1975.

Barry Mitzman, "Seeking a Cure for Mathophobia," American Education, March, 1976.

Sheila Tobias, "Math Anxiety: What It Is and What Can Be Done About It," to appear in Ms Magazine, Fall, 1976.

(5) A limited number of mini-brochures are still available on request.

(6) The speakers for these topics were:
Lucy Sells, sociologist, U.C. Berkeley and the American Sociological Association.

Carol Lennox, computer specialist, Stanford Computer Center and Coordinator for Computer Activities at Mills College.

Dr. Ravenna Helson, Psychologist, U.C. Berkeley.

Dr. Judith Kunofsky, mathematician, Sierra Club.

Dr. Bonnie Miller, theoretical astrophysicist, U.C. Berkeley and Michigan State University.

Grace Adams, doctoral candidate, U.C. Berkeley in electrical engineering.

We believe that engineering is one of the most exciting new options open to women today and feel that combining engineering training with other interests can lead to many creative career possibilities. Several seminar speakers have discussed various stimulating combinations, for example: interest in the environment and civil engineering (e.g. design of pollution control devices), interest in the health sciences and mechanical engineering (e.g. design of artificial limbs and other prosthetic devices), interest in economics (government, business, management, human relations or computers) and industrial engineering.

We have instituted and publicized a dual degree program in which a student spends three years at Mills and then two years at one of the participating engineering schools, thereby receiving a B.A. degree from Mills and a B.S. in engineering, as well as in some cases, a masters of engineering. In the planning stage for next year's departmental seminar is a series of talks focusing on more elements of engineering, e.g. the engineering process, analytical tools used by engineers, and a specific case study of an engineering problem. Also in the planning stage is a cooperative effort with the Career Center on campus to coordinate speakers and field trips to local industries with beginning courses in math and computer science, thus emphasizing real-world applications of course material.

(7) One of the best references for this approach I have seen is a Russian high school text, Functions and Graphs, by I.M. Gelfand et al., M.I.T. Press.

(8) To counter the obviously bad effects of formula memorization and routine plugging in, we go to the extreme of not allowing students to use formulas (not even the quadratic). Along the same lines, it is also essential to stress the importance of guesswork and approximations in mathematics, even in quantitative calculations.

(9) I directed the pre-calculus project last year. This year it has been under the direction of Steve Givant, former director of the Bay Area SEED Project (a program designed to teach disadvantaged elementary school children advanced mathematics). Steve has contributed many new ideas, including the discovery approach and the introduction of more calculus concepts, even at this preliminary stage.

(10) The teaching assistants are undergraduate students who receive course credit for their work; the main criterion in selecting them is their interest in participating in the project. They are told the general goals of the workshops and are asked to: design a flexible and revisable plan for the semester; assign regular homework sets; keep weekly records, including evaluations; and monitor regular attendance of their students. The T.A.'s meet with the course instructor regularly to discuss progress and problems, and attend workshop sessions stressing the effectiveness of letting students work things out for themselves. Except for this guidance, the T.A.'s are on their own.

The psychological benefits derived from peer teachers, and the enthusiasm and conscientiousness of these teaching assistants certainly counter their lack of previous teaching experience. Furthermore, the workshops provide an invaluable learning experience for the T.A.'s, who must first organize and clarify mathematical concepts for themselves in order to communicate these to others.

Last year the teaching assistants were mainly upper division math and science students. This year many of the T.A.'s were students who had themselves just recently come through the basic program. Again the benefits outweigh the lack of experience. For their students, these T.A.'s are superlative role models who can also empathize with their problems. For the T.A.'s, teaching experience helps to internalize their newly acquired mathematical self-confidence.

(11) It quickly became apparent that workshops also could serve many other student needs, and hence affect an even larger number of students. For example, many Mills seniors had not studied mathematics since high school and were apprehensive about taking the Graduate Record Examinations (quantitative part). Some psychology and social science students, including a number of older women resuming their studies, were quite anxious about taking the statistics course and requested special workshops. We felt that these were legitimate needs and so graduate exam workshops and pre-statistics workshops were also initiated. The mean G.R.E. score for students participating in the program was (in 1974-1975) 100 points higher than the Mills mean score in the year 1972-1973. (Results are not yet in for 1975-1976.) For follow-up support we have also added calculus workshops this year.

The workshop format also has proved successful in other contexts. A network of computer workshops is being developed under the direction of Carol Lennox, Coordinator for Computer Activities. Drop-in computer workshops were held daily in the fall (in addition to the usual introductory computer course), where anyone could learn the basics of logging on to a computer, utilizing existing programs, flow charting and writing and running simple programs. Two students (in psychology and sociology) ran computer workshops implementing SPSS (The Statistical Package for the Social Sciences). A computer science student led a systems workshop for graduate students in music who were interested in building a computer interface for their Moog and Buchla synthesizers.

Since we feel that the effectiveness of this workshop project is dependent on continuous attendance, we require that all students participating in regular workshops must formally enroll (for ¼ or ½ credit, depending on work required; they are graded on a pass/fail basis where a pass requires steady attendance).

(12) We now are offering two calculus sequences: students who are sufficiently prepared enter a regular calculus sequence directly in the fall semester; students who are inadequately prepared enter the pre-calculus course in the fall and then a specially designed follow-up calculus sequence starting in the spring. Obviously, it is important to place students in the proper sequence. In order to do this, we consider the students' previous mathematics record, results of the self-placement quizzes, and recommendations from individual counseling. Even so, there is an occasional misplacement.

(13) This year we experimented with a course in problem solving taught by Denny Brown, who incorporated ideas resulting from recent research into problem solving by psychologists and computer scientists. Thirty-one students enrolled, about half of them with very weak math backgrounds. Several weeks were spent working on conceptual, perceptual, emotional and cultural blocks (using Adam's book, "Conceptual Blockbusting"), and several weeks were devoted to symbolic logic (developing terminology, discussing the nature of inductive and deductive reasoning, nature and types of proofs). Mainly, however, the course consisted of posing and solving a large variety of problems (e.g. Tower of Hanoi, counting, truth-teller, missionary and cannibal, sampling, and scheduling problems). These were followed, as the course progressed, by problems having more mathematical and scientific content. The presentation also utilized different styles of problem solving techniques (e.g. tree search, reasoning backwards).

A very effective technique was to have students keep a journal recording in detail their solutions to problems, how they got them, how they felt about them. Students responded enthusiastically; we plan to continue this course and also to implement many of its ideas into the workshop project.

(14) In order to find out more about the projects that my students were working on, to do some research of my own, and to find

out first-hand what it's like working in industry, I spent a month last summer at the IBM San Jose research facility in their Visiting Faculty Program. This was my first experience in an industrial research environment. In contrast with the academic scene, I found that there is more emphasis on team effort, real-world inspired problems, and solutions with practical constraints, e.g. in terms of time, money, number of steps, and size. These can actually pose very challenging theoretical problems.

3. MINORITY WOMEN IN SCIENCE

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It is difficult to organize a few statements regarding minority women scientists. Owing largely to their double negative status, minority women have concerns in each of the areas being covered in other conference discussion groups which are distinctly unique and whose consideration in this discussion is limited by time factors. Because minority women are a non homogeneous group, it is difficult to make any general statements which would not sacrifice the special treatment which their differences demand.

The problem of reporting on minority women scientists is further complicated by the lack of adequate and accurate data on this segment of our society. Available data is obscure, contradictory and dated.

The common practice of double recording (minorities and women) proves very misleading and further contributes to the unreliability of the data.

Most of the available data regarding the numbers of minority women scientists usually applies to the doctorate level and to Black Women. Data including other minority groups have come from census reports or from studies conducted by the National Scientific Manpower Commission. The latter of these two sources seems most reliable and most recent. Betty Vetter, executive director of the Scientific Manpower Commission has, in a series of articles and papers, presented most of the recent and accurate data regarding the extent of participation of minority women in the field of science and engineering. In a paper prepared for the AAAS conference on minority women scientists she reports that among U.S. doctoral scientists and engineers, the representation of minority women in science as compared to their representation in this country is as follows.[1]

	% in U.S.	% Doctoral Scientists & Engineers
Black Women	6%	0.1%
Native American	0.4%	.04%
Women of Spanish Origin	2.2%	0.1%
Asian	.35%	.34%

Vetter further cites studies made by the National Research Council in 1973 which show that in a total workforce of 244,921 scientists and engineers there were: 249 Black women, 3 American Indians, 837 Asian Americans and 34 other minorities (not defined) who were at the doctoral level. These 1,123 women represent one half of one percent of all doctoral scientists and engineers in 1973 who reported their race.

A study of the number of doctorate degrees granted to women and minorities by AAU universities[2] shows that between 1972-1975

	Degrees received by minority women	Total degrees awarded
Life Sciences	74	6,012
Mathematical Science	9	2,353
Engineering	4	5,484
Health Professions	21	1,256

These figures may not reflect a true pattern for Black scientists. James M. Jay of Wayne State University[3] states that there has been a significant decline in the number of doctorates awarded to Blacks by AAU universities related to the proximity of non AAU universities to Black feeder schools (Southern Black undergraduate colleges), and to the fact that these schools are relaxing their segregated admission practices.

Information concerning minority women scientists below the doctoral level is even more obscure. Vetter cites statistics[1] provided by professional societies which are felt to be unreliable because of the minimal participation of minorities in these societies.

In chemistry, women have earned 19% of the bachelors' degrees, 20.8% of the masters' and 7.3% of the doctorates since 1960. In 1973 they earned 9.7% of the chemistry doctorates.[4] Although this report shows no breakdown of the women as to race/ethnic groups it was found that in that same year Blacks comprised 1.2% of the doctorates.

In engineering in 1974, Blacks received 1.8% of the bachelors' degrees. Men and women of Spanish origin received 2.5% and American Indians were less than 0.1%.[4] A study of 148 engineering schools in 1973 showed the enrollment to include 39 Black women, 24 Spanish surnames, 41 Asian/Oriental, 1 American Indian and 208 "other" minority women (undefined).[1]

Despite the paucity of data, there is sufficient information in these data and others to confirm that minority women, like majority women, represent a very small fraction of the entire science and engineering work force and that their representation in the fields of science and engineering is not in proportion to their representation in the country. It is obvious that this underrepresentation of minority women presents a serious obstacle to the economic and social development of the ethnic groups which they represent as well as a serious loss of "womanpower" for the nation.

Review of the Conference of Minority Women Scientists[6]

Speculation as to the causes for the lack of significant involvement of minority women in science has filled many volumes. "Who are the minority women scientists? Why are they so few in number? What are some of the factors which prevent their participation in larger numbers? Perhaps no one knows the answers to these questions better than minority women scientists themselves.

In a conference on minority women scientists organized by AAAS in December 1975, a group of minority women scientists were asked to identify factors which helped or hindered their pursuit of a science career. They were asked to address themselves* to three time periods: pre collegiate, collegiate and professional education, and career and professional. An attempt will be made to summarize some of the factors presented by the women at this conference which hindered their scientific pursuits. If time permits, an informal discussion of motivating factors and recommendations made by the conferees will follow.

Pre Collegiate

Participants of the conference noted the impact on minority women of stereotyping in the choice of a career. The absence of role models in their home communities made a significant difference in the way in which others reacted to their interest in science. Although sex stereotyping presents a serious problem for all women, cultural patterns in many minority communities make it even more inhibiting for minority women. Mexican American participants felt that the need for female role models was for them even greater than the need for co-ethnic models. They stressed the importance of this factor in motivating young Mexican American women to consider careers in science. Many conferees felt that the lack of role models contributed to the fact that many had experienced alienation from their communities as a result of advanced training or training in a less traditional field. Although this experience was shared by members of all groups, Black participants had experienced it to a lesser degree.

The need for increased visibility of accomplished minority women in the media as well as in all levels of industry, academia and government was underscored as a means of reducing the impact of this problem. The conferees recommended the establishment of projects and programs for the express purpose of exposing young minority women to science and scientists of their own race/ethnic group.

Ironically, the bias which is perpetuated against minority women is often held by the professionals to whom they turn for aid. There was a general concern for the entire area of counseling which drew considerable criticism from the participants of all groups. Too frequently minority women are typically guided into career patterns based on stereotypic attitudes and expectations rather than on values, abilities or well developed interest. It was noted by conference participants that there was very little information imparted to them by secondary school counselors in the areas of financing for higher education, career options or comparisons of schools and programs. It was felt that information of this type is especially important for minority women who have little information from other sources. It was suggested that young minority women be encouraged to make career choices which maximize their intellectual potential, and to select courses which create the greatest number of career options.

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* Women attending this conference were of four ethnic groups: Black, Mexican American, Puerto Rican and Native American.

Expressing strong dissatisfaction with the educational system in general, conferees criticized such areas as:

(1) lack of motivation on the part of many teachers
(2) insensitivity to and ignorance of many cultural value differences on the part of teachers
(3) failure on the part of the educational system to accomodate for language differences
(4) inadequate science facilities
(5) teacher expectations

The area of inadequate science facilities was stressed by the Native American women who found BIA schools extremely inadequate and who expressed an urgent need for training in the areas of engineering and medicine. Other participants noted the absence of lab facilities in the schools which they attended.

Teacher expectation was felt by the women to have had a great impact on their performance. Many reported that majority teachers frequently expected a lower level of performance from minority students. The positive effects of teachers who expected much of them and who attempted to motivate and encourage their interest was noted by the women.

Collegiate and Professional Education

Financing a science education was a problem of some magnitude for many of the women during this period. The previously mentioned areas of teacher motivation, counseling and role models were seen as problems by many conferees in this period as well. Financing however was perhaps of more concern for many. Conferees agreed that the cost of obtaining a doctorate degree in a science is prohibitive to most minority women, and stressed the need for adequate financial counseling. Barbosa[5] states that most blacks receive financial support for undergraduate training from sources other than parental thus students seeking a doctorate have the financial burden of the undergraduate education added to that of graduate school. They further feel that the solution to this aspect of the problem of underrepresentation of minorities is critical to the solution of many other aspects.

Social and personal problems related to sex and race/ethnicity were noted. Many schools fail to offer support structures to minority women once they are admitted. Subsequently, many conferees expressed feelings of peer and co-ethnic alienation, loneliness, exclusion from study groups and social groups. Attendance at minority schools by some of the women lessened this problem although many reported that such schools frequently were less well equipped than majority schools.

Sex stereotyping was a major issue as the women expressed the frustration of pressures from peers and family to conform to roles traditional for their sex and/or race/ethnic group. These women felt strongly that while racism represented the greatest obstacle to the pursuit of a science career in the early years, sexism was more significant in graduate and professional schools and in employment.

Career and Professional

There is no evidence to indicate significant unemployment of minority women scientists. Perhaps the problem is one of underemployment. The conferees noted the differences in salary packages offered to minority women scientists which were often well below those offered to men with the same training and experience. They criticized the unfair practices of promotion and job assignments and generally agreed that men advanced at a much faster rate even in instances where men and women begin at the same level.

The conferees criticized those systems which penalized them for engaging in activities associated with addressing the problems of minorities. They also objected to the double counting system, by which employers count minority women twice, thus distorting statistics in order to avoid hiring more minority women.[7] They also agreed to oppose institutions and programs which pit minority groups against one another.

The 30 conference participants mentioned were selected from 200 persons nominated by their colleagues. They represented various ages, fields, and experiences and shared in common the fact that they were all distinguished in their field. These women must certainly be commended for their achievements in spite of the monumental barriers they had to overcome.

We know very little in terms of numbers about the participation of minority women in the sciences. We do know that more information is needed in this area to form a base for evaluating affirmative action programs and for making recommendations for changes in these programs. Minority women scientists must be placed in higher decision making positions within our government, schools, industry and private sectors in order to have a more significant impact on those issues which effect their numbers, images and levels of participation in the sciences. All minorities share to some degree the victimhood of sexism and racism. It is important that they avoid efforts which attempt to polarize and isolate them and their efforts from each other.

Discussion

Much of the discussion centered around counseling. When asked to give her opinion concerning the problems of minority students and counseling, a minority counselor stated that one of the major drawbacks in this area was that some minority students, for a variety of reasons, do not avail themselves of the counseling services at their disposal. This counselor further added that peer pressure among minority students encourages them to more frequently rely on the advice of peers for information concerning the selection of courses and career options etc. Since many students typically view science as difficult, masculine, etc., reliance on this type of advice alone may prove discouraging for young minority women. It was suggested that minority women counselors and instructors increase their visibility among minority students on their campus so that minority students will be more encouraged to seek their advice. It was also suggested minority faculty and counselors increase their involvement with science career workshops etc. in order to add the dimension of race/ethnicity to questions that minority students may have.

The positive effect of attendance at a women's college on the selection of science careers was noted. One counselor at a women's college commented that the students at these colleges tended to relate more positively to careers in science and other non-traditional fields. She stated that often the number of women faculty at these schools is above that in co-ed institutions so that the lack of role models is not such a critical issue. It was felt that this could also be related to the absence of negative male imput from male peers.

A young minority student in attendance who is currently enrolled as a biology major at a local university expressed extreme frustration and disorientation with respect to her participation in that department and her future career plan. She related feelings of loneliness, stating that her involvement with the faculty and other students was minimal at best. When asked about her contact with counselors, this student stated that she had not talked to any counselor and that her express purpose for attending this conference was to seek help. A counselor in attendance recommended several sources whereby she might obtain information on financing graduate work and on possible career opportunities in her area. She was also advised to consult minority women counselors and instructors on her campus to talk more specifically about the problems of minority women and to seek other minority student groups as a source of emotional support. Another minority student in attendance was a physics major who was very actively involved in an attempt to convince an all male department to fill a soon to be vacated position on the faculty with a female. She reported extreme disinterest on the part of other students and faculty in this effort, and sought advice on the best manner in which to present her concerns to the physics faculty. There was some concern that her future as a student was in jeopardy as a result of her efforts. She felt that other students did not want involvement because of this. Another participant suggested that she might enlist the support of female faculty members from other departments in her efforts. Names of women physicists who might recommend possible candidates were given. It was suggested that she make every effort to inform these women of the possible opening. She was not aware of the existence of an affirmative action officer on her campus, but was advised to find out and seek his/her help in the matter.

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4. Pre-College Preparation of Women in Mathematics and Science

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To some readers the title of this paper may not be of any importance. Their thoughts might be: why is that a topic of special concern? or, why is the preparation of women any different than that of men? My responses would be that societal conditions are telling us that the pre-college preparation of women in mathematics and science is lacking and of some concern, and coupled with educational data they seem to imply that yes, female preparation in the technical fields is different than male preparation.

We know that pre-college educational preparation for any individual is one of the foundations for future educational and occupational options. If the former is lacking or inadequate, the options are limited. In this paper I will focus on mathematical and scientific preparation of women and suggest some practical directions for action to equate opportunities in these fields. In particular, three questions will be addressed:

1. What are existing conditions?
2. What does research tell us?
3. Whan can we do?

Existing conditions

Even though we live in an age of rapidly advancing science and technology, women remain underrepresented in scientific and technical fields. This may not be by choice. In 1973 less than 9% of doctoral scientists and engineers in this country were women. Less than 1% of the engineers were women. Median salaries of women in these fields is 11-20% below that of men. In the academic ranks and in institutions of higher education, women are minimally represented, particularly in positions with promotion.

Much of the literature in psychology and sociology reveals that women are inclined toward occupations which are socially oriented and males toward investigative and analytic work. We might note that the latter are certainly important characteristics for scientific endeavors. Yet these inclinations may not be wholly by personal "free choice." Eleanor Maccoby in The Development of Sex Differences notes:

> "...members of each sex are encouraged in, and become interested in and proficient at, the kinds of tasks that are most relevant to the roles they fill currently or are expected to fill in the future. According to this view, boys in high school forge ahead in math because they and their parents and teachers know they may become engineers or scientists; on the other hand, girls know they are unlikely to need math in the occupations they will take up when they leave school."[1]

Let us now look specifically at educational data. High school females elect less mathematics than their male counterparts (College Entrance Examination Board, 1974-75). Lucy Sells found in 1972 at the University of

California, Berkeley, that among entering freshmen, 57% of the males had four years of high school mathematics and only 8% of the females, the same. This is not only statistically significant, but quite important when one notes that the four years is prerequisite to the entry level mathematics sequence for majors in the scientific and technical fields. Sells terms mathematics the "critical filter" as it cuts down the future percentages of women in those fields.

Female students tend not to perform as well on tests of mathematical abilities (Aiken, 1970; Mullis, 1975), yet validity of instruments and comparability of samples remain critical research questions. Generally women feel less mathematically, mechanically, and scientifically able than males in high school (Erlick and LeBold, 1975). These patterns seem to continue through college work and graduate studies (Hansen and Nenjahr, 1973). Yet these sex differences in mathematics achievement do not seem to appear before the seventh grade (Hilton and Berglund, 1974). Socialization and sex-role stereotyping appear to be major factors related to the fact that young women are rarely motivated or encouraged to excel in mathematics and science and do not view those subjects as potentially useful in future lives. Avoidance and anxiety related to science and mathematics remain part of that "critical filter." And as noted the lack of pre-college preparation in mathematics and science greatly limits possible educational and vocational options and the efficiency with which they may be attained for any young women.

What research tells us

I will focus here on a few studies that are of particular relevance to this topic. The literature is increasing in number as more interest is created and critical need revealed in this area. Recently the National Institute of Education (NIE) Women's Research Program announced plans for a research program on women in mathematics and more and more undergraduate and graduate researchers and private individuals are looking at the issue.

National Science Foundation (NSF) supported a series of studies over the past few years aimed at looking at ways to increase the number of women in science and technology. Of some importance is a study by Barbara A. Kirk entitled "Factors Affecting Young Women's Direction Toward Science-Technology-Mathematics" (1975). Kirk[2] sampled 500 San Francisco Bay Area young women and 102 young men. All were high school seniors who had scored in the upper 20% in mathematics on the PSAT. Criteria of science- and math-boundedness were developed and intensive interview and questionnaire techniques employed in the study. (A summary of Kirk's conclusions is given in discussion Group 8.)

Further study of this type is encouraged by Kirk at later timed intervals, and she suggests practical action which I will summarize later in this paper.

Another study of particular interest is the popular "Mathematics and Sex" conducted by John Ernest and his research team at the University of California, Santa Barbara, and published in January, 1975. A sample of 1324 school children from grades 2-12 was involved and no statistically significant sex differences were found with regard to liking mathematics. Yet, as Ernest points out when mathematics becomes optional, fewer women take it. His conjecture is that men take it at this point in education because they are more realistically aware of its future need in career options. And they envision a full set of options, not necessarily the case for young women.

Ernest notes two stereotypes of relevance here. The first is the notion that women mathematicians are less feminine then non-mathematicians. He claims it preposterous and with no empirical base. The second stereotype is that women are "poor at figures" and this is quite well supported by the media.

Perhaps of greater importance in the Ernest study is the discussion of the various attitudes of parents, teachers, and students which surround the study of mathematics. He notes that it is the father who will help with mathematics homework, while mother will help with most other subjects. In a small sub-sample of teachers, more than half felt that boys are better than girls in mathematics, but not one felt the reverse true. These attitudes persist, as Ernest points out, among students themselves. He also notes that the sex difference research includes many conflicting results due to great variability and questioned validity in the measuring instruments. According to Ernest, there is far more variation within each sex group than between the sexes. With the above stereotypes and attitudes, John Ernest does not find it too surprising that we find a lack of women in the science and mathematical fields. He makes some practical suggestions for educators and these will be discussed later.

Another notable study worth mentioning here is that of Patricia Casserly entitled "An Assessment of Factors Affecting Female Participation in Advanced Placement Programs in Mathematics, Chemistry, and Physics," supported by the National Science Foundation. Of most import are her conclusions which are consistent with others that counselors and teachers and parents must be sensitized to encourage all students to go on in mathematics and science even if interest seems vague and undefined. She encourages the use of older girls and women in role model capacities to work with younger students. This notion brings us to an appropriate time to discuss other practical suggestions gleaned from the literature and elsewhere that will help in encouraging more young women to adequately prepare for future careers in scientific and other technical fields.

What we can do

Young women do take mathematics and science, but they generally do not take enough to efficently prepare for particular technical careers if they choose them. Existing societal conditions tell us, as do the young women themselves, that action is needed both in terms of intervention and change. Practical suggestions need to be developed.

Along with other researchers and educators, Kirk and Casserly support the notion of role models. They encourage older girls who have been successful in high school mathematics and science to discuss opportunities and advantages of their choices. Providing women from the field could also be a positive resource. Recently at a young women's conference ("Expanding Your Horizons in Mathematics and Science") for grades 7-12 sponsored by a group of San Francisco Bay Area women, girls too emphasized the importance of seeing and talking to women scientists, engineers, and mathematicians so "they could see themselves in that possible role."

Since there are widening sex differences, early attention to young women in mathematics and science is vital. Kirk suggests offering "early and continuing opportunities for girls' exposure to and participatory activities in math, emphasizing discovery, not rote and relating the content of the activities to students' present and future lives."

Attention must be given to early attitude formation and awareness of differences in conditions that might affect later options. John Ernest encourages uncovering sexism in educational practices and media and taking action against it. We might look not only at curriculum materials, but also at adult behaviors and resources available. Are young girls encouraged in investigative/exploratory situations? Do they have adequate exposure to mechanical materials? Do they have maximal involvement and rewards in math/science related activities.? Patricia Casserly encourages the sensitizing of counselors, teachers, and parents to the necessity of desexing career expectations and encouraging all students to accelerated in math "even if their interest seems vague and undefined."

Teacher preparation and behavior is certainly a pervading and crucial variable. As suggested by many educators, including Ernest, the use of mathematics specialists in the elementary schools could be of great help. It is most difficult for the elementary teacher to cover all content areas and show equal "excitement."

Encouragement for young women in pre-college preparation in mathematics and science must come from many sources. Counselor and other guidance related personnel must be aware of misguided and incomplete information they might have. They must be responsible for equal counseling practices which include encouraging young women in technical areas, even if those areas are unfamiliar to their own backgrounds. Career guidance must offer complete information regarding course prerequisites so that realistic career aspirations may be formed.

Action programs need to be effected. One example is the "Math for Girls" course at The Lawrence Hall of Science in Berkeley. This course supplements school mathematics and is a voluntary offering for young women in the middle grades. Field trips and career programs at the elementary and other levels may be built. Groups of women mathematicians, scientists and engineers could spend time on school sites working with young men and women in science/math related activities.-- encouraging, exciting, and modelling so that students' images of their future potential is changed.

Parents must be a full component of any program. They too must be made aware of stereotypic attitudes and behaviors which influence their daughters' competence and expectations.

The possibilities are great for both men and women. Action is needed. If we view the existing conditions and the pre-college preparation as a limiting factor, then we are not providing an equal educational opportunity for many young women. An equal educational opportunity means equal chances in educational and occupational choices. More adequate pre-college preparation can lead to greater possibilities for many women in science and technology. This implies increased human potential. And that cannot help but benefit all.

Footnotes

1. Maccoby, Eleanor (Ed.). The Development of Sex Differences, p. 40.

2. Kirk, Barbara A. "Factors Affecting Young Women's Direction Toward Science-Technology-Mathematics," pp. 205-210.

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5. Towards a New Concept of Affirmative Action for Women

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In recent years the failure of women to achieve eminence in many aspects of life, especially in academic and scientific areas, has been noted quite often. The failure of many educators and researchers to consider that the sex difference in achievements of adults was a serious educational problem is somewhat understandable in light of our society's expectations for women in the past. Today, however, the issue of the fulfillment of promise for females as well as males must be considered. We should not ignore psychological and biological differences between males and females that relate to their achievements in the classroom, their sense of personal worth, and their successful adjustment to adult life.

A major premise of this paper is that affirmative action programs for women aimed only at removing external barriers to professional careers for women will be less successful than affirmative action programs which begin early, encompass many social aspects of development, and deal with internal barriers to success, as well as external ones.

Since the types of students who can realistically aspire to professional careers in the sciences are those whom society could identify as intellectually gifted in childhood, I believe that research and program planning for the gifted should be considered fundamental concerns of affirmative action plans. I believe this has been overlooked by many persons who are interested in increasing the participation of women in mathematics and science.

In order to expand our concept of affirmative action programs, let us examine what is known about sex differences and academically talented students and their implications for affirmative action strategies. First, we will consider a brief summary of sex differences in the cognitive and affective domain. Second, we will review some of the general types of accelerative and non-accelerative educational strategies which are currently being advocated for the gifted with respect to their usefulness for males and females. Third and last, we need to consider the relationship of specific recommendations for programs for gifted at the elementary and secondary level to affirmative action strategies for women in the mathematical and scientific professions.

If we are interested in fostering greater interest and achievement in science and mathematics among gifted girls, we must be selective in advocating educational change or innovation. On the basis of the existing evidence concerning educational aptitudes, interests, and achievement of gifted girls, five major areas of concern for future research, program planning and affirmative action strategies can be identified.

The first area is that of sex-role stereotypes. Creative and productive behavior of both males and females in school and in life is likely to increase as unrealistic sex-role stereotyping of activities gives way. The ideas that smocks in art classes or aprons in cooking class threaten the sexual identity of males while aprons in shop class cause the loss of femininity of females are no more absurd than the ideas that science is a male domain and poetry is for sissies.

Gifted boys and girls both need moral and intellectual role models who exhibit the heights that gifted persons can achieve. For girls the exposure to women who utilize the full range of their talents and gifts seems particularly crucial.

Counselors and teachers need to become more aware of the special needs of the gifted learner, as well as the general problems of sex-role stereotyping. If teachers are to prepare children for the future they must themselves be helped to understand social change and adjust to it.

Parents, as well as educators, need to become aware of the negative outcomes of early sex-role stereotyping. Parents of gifted children should be counseled about the talents of their offspring as early as possible. Parents of girls may need urging about the values of certain so-called boys' toys and games for their daughters. Parents of gifted boys may need encouragement to be tolerant of their sons' aesthetic and verbal interests. Perhaps groups such as the National Association for Gifted Children could experiment with counseling centers for parents of the gifted.

A second issue is that of homogeneous grouping or tracking. It has been suggested that "tracking" for science and mathematics classes in high school is a form of discrimination against girls. The rationale for grouping students needs to be examined. For some subjects sex segregation might actually foster greater achievement of girls — at least during early adolescence.

Whether or not students are actually segregated into special classes or dealt with in teamed class situations, some attention to interest should be considered. Perhaps students with mathematical talents and interests (boys) would enjoy language classes more if they read and wrote articles related to mathematics and science. What would be the result of offering a course in mathematics or science taught in German or Russian? Perhaps students with strong social interests (girls) would appreciate mathematics more if the course was interlaced with applied problems of a social nature. Courses in statistics and mathematical psychology could be developed which also taught the basic mathematics of algebra through calculus.

Perhaps children would become more creative if educators and parents set better examples in their approaches to teaching. In life, skills are far less compartmentalized than in school. In life, ability, interests, and experience play greater roles in work situations and assignments than age. Yet in schools chronological age is the major factor that determines what child learns what topic at a given level. Gifted boys and girls would both probably benefit if attention to readiness and interest for learning were more important than age.

This leads to the third area of concern: the acceleration of learning and appropriate content for the gifted. At the first World Conference on Gifted, Gallagher (1975) stressed quite eloquently that the major need for progress in educating the gifted is the development of appropriate content to be studied. In mathematics and science such content has been well developed. The problem for gifted learners is one of allowing them to study the mathematics and science content at the most appropriate time and pace. For example, SMPY[1] has clearly demonstrated that some sixth and seventh graders can easily master the content of algebra and geometry at a high level. The problem is how to adjust the school program to allow the natural transition from computational skills to abstract mathematics to occur at the right time for the gifted learner. In the case of girls this problem is particularly difficult because to learn this material at the appropriate time often requires some type of acceleration of grade placement, either in the subject or overall.

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[1] Study of Mathematically Precocious Youth at The Johns Hopkins University

Gifted students, particularly girls, would benefit from changes in school environments that create greater flexibility in the content presented to a given student at any age. The concept of the ungraded school is to be lauded. But, unfortunately, this concept is too often more limited in practice than in theory. Self-pacing independent study is also less than ideal. Talented children need to interact with their intellectual peers and can benefit from the guidance of good teachers.

The acceleration of learning of appropriate content is the major issue. At present, some form of grade-skipping, or at least subject-acceleration, is all that is available to most gifted students. Although these methods do work, they are unattractive to many - especially gifted girls. The ultimate solution for the gifted child, as well as the slow learner, is the abolishment of age-grade segregation.

Stanley (1959) has proposed longitudinal teaching teams in various subject matter areas. This concept needs to be expanded and tested. It is possible that the creation of learning centers with specialists in subject areas who develop long range curriculum programs for students might eliminate some of the problems of desegregation as well as problems of the "deviant learner". Major changes in educational strategies come slowly. Thus, while one the one hand educators should experiment with innovation, on the other hand they must deal with today's gifted children who exist in less than ideal situations.

This leads to the fourth critical issue: the need for early identification and planning for the gifted child. Some parents recognize early that their child is exceptional. The extremely precocious child who learns to read at age three or four is not likely to go unnoticed. In some families, however, the gifted child may not be recognized.

Given the present educational process, early entrance to first grade would seem to be desirable for most very bright students. Early entrance is particularly desirable for girls since later acceleration is less appealing to them. Early entrance to school is also likely to benefit the child from the educationally disadvantaged background. Yet few school systems encourage early entrance. Clearly, better screening procedures would seem needed to identify children who should enter school early. Research is needed to devise ways of finding talented students early to foster advanced school registration. The concept of Head Start seems to be truly needed for gifted girls and the children from educationally disadvantaged homes.

Early identification and admission to kindergarten or first grade by itself is not enough. Program planning for the advanced learner needs to be started early and continued through college. For girls, early tracking into academic programs that lead to Advanced Placement courses and early high school graduation seems imperative. The gifted learner will need the level and stimulation of advanced course work earlier than others. College level work may be necessary for the very bright learners when they are only ten to fifteen years old. Exactly how this is handled for each child will vary. There is no single solution to fit all gifted students.

This leads to the fifth and final issue of concern: counseling for the gifted girl and her parents. Since there can be no single plan for all children, there is a real need for early educational counseling and planning services for the gifted girl. Gifted girls and their parents must be alerted to the various alternative strategies that exist in order to plan a program. It appears that girls, more than boys, need early counseling about the value of advanced placement courses, early college admission, and studying mathemamatics and science. Sensitive Counselors are needed who will stimulate, not discourage, the intellectual interests and achievement of gifted girls and boys.

Gifted girls need some career awareness and counseling programs at an early age. Most likely this needs to be a long term continuing process program. The model needs to be developed.

America needs talented scientists, artists, gifted leaders, and informed, concerned citizens. All children today need educational programs that prepare them for the demands of the future. Gifted learners are too often frustrated rather than helped to fulfill their promise by the unnecessary rigidity of our present educational system. The gifted child, especially the female child, is often discouraged from seeking intellectual challenge. Thus, affirmative action programs for women should deal with the realities of the early influences of parental attitudes, teacher attitudes, and educational environments which shape gifted girls' views of their own competencies and future expectations. Affirmative action programs that deal with external barriers at the adult stage will not overcome the internal barriers to achievement in the sciences that have evolved during the formative years. Affirmative action should include all of the following and more:

a. Programs aimed at changing the attitudes and behavior of parents and teachers that discourage girls' participation in mathematics and science at an early age.

b. Early career education programs for gifted girls which provide for contact with female role-models.

c. Greater support of programs of early identification of gifted children -- particularly gifted girls for math and science experiences.

d. Greater support of flexible educational alternatives, such as cross-age grade grouping, ungraded schools, etc.

e. Continued efforts to keep society aware that a problem exists.

f. Continued support for research and intervention experimentation.

g. Awareness that programs for the gifted at the elementary and secondary school level need to be seen as crucial components of the overall concept of affirmative action for gifted girls.

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Summary of Points Discussed

Pauline Sears from Stanford: Study of career satisfaction of women in the 1960's.

Affirmative action programs need to do more than remove external barriers - Since intellectually gifted children are identifiable in early years there is need for differentiated educational experiences for gifted (academically)

What's known about sex differences?

A. Balancing of test items tends to dilute differences in cognitive abilities between men and women.

B. Math tests may be more representative since items not couched in verbal settings specifically male or female.

Some sex differences identifiable as early as age 9.

C. Johns Hopkins Study of Mathematically Precocious Youth

1. 263 7 & 8th grade boys and 47 girls scored at level of entering freshmen on SAT.
2. highest boys' score: 790; highest girl: 600.

There may not be any innate aptitude differences, but in math achievement boys already ahead of girls by age 9 becuase of social influence and input.

D. Study of toys in Sears Catalogue to see which toys recommended as specifically male or female over 20 year period -- shouldn't we direct affirmative action towards this elementary level of influence on children. Comment that in China children use manipulative skills (abacus) to teach math rather than our attempts to abstract to reading numbers in early years.

Incoming immigrant chinese show unusual ability to think in spacial configurations — could this be a result of dealing with Chinese characters?

E. Verbal superiority of girls found before age 3 and after 11 (Maccoby), but SAT results do not bear out these performance differences.

F. Spacial visualization studies tend to show distinct male superiority and inheritability (boys can inherit from one parent while girls need to inherit from both parents).

G. Not same pressure on girls as exists for boys to encourage skills which will have job relevance.

Quantitative ability of boys tended to decline where father away during formative (3 months - 6 years) period.

(Less likely that verbal ability will fall off in either sex because we deal in verbal medium.)

H. 7th and 8th grade boys offered college level math courses couldn't wait to line up, while girls were not interested even when money was not involved.

I. Summer math program for sixth graders

J. Early career decisions - commitment as early as age 12, or before leaving high school. Support (or non-support) from influential teachers and/or family members.

K. Career awareness projects may be funded by N.I.E. -

What kinds of implementation should there be for expectant parents

Gifted A. P. high school girls encouraged by science teachers on the one hand were undermined by guidance counselor

Women who went on to Ph.D. tended to have career oriented mothers or to identify strongly with their fathers.

L. Research to identify what are the most productive strategies for encouraging gifted girls -

  1. road spectrum research on all levels may easily boil down to pinpoint levels where supportive influences are most effective
  2. Nation-wide cooperation so that efforts are coordinated or exercised in many differenct geographical settings.

Issues

What are the relative impacts of significant others - parents, teachers, peers - upon the development of interest in science and mathematics?

What types of intervention should be attempted to increase the participation of women in science. Members attending the session differed on this point:

Some felt that the most important group to re-educate were parents.

Others felt teachers were more important.

Some feel the experience of meeting a scientist at an early age can be very important.

Others felt this was not likely to very effective in stimulating girls who did not already have interests in the areas and support from teachers and family.

6. PROBLEMS OF FEMALE PRE-MEDS

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Basis for discussion in this group was the section on "Women in Medicine" of the recently completed Exploratory Study of Women in the Health Professions Schools. This study was prepared for The Women's Action Program, Office of Special Concerns, Office of the Assistant Secretary for Planning and Evaluation, Department of Health, Education and Welfare by Urban and Rural Systems Associates (URSA) of San Francisco. (Contract: HEW OS-74-291)

Included in the HEW study were interviews with women presently in medical school. When their experiences were compared with those of Bay Area pre-meds as described in the discussion group, the similarities were striking. A particular problem was the failure to receive encouragement to pursue medicine even when women were not actively discouraged. In contrast to men, women pre-meds are often asked to justify their choice of medicine as a profession, to define it, rather than being given "automatic encouragement and support."

A recurrent theme was the problem for women of combining societal and personal expectations for marriage, child bearing and rearing and home-making with the intense demands of medicine as a profession. Recognized as realistic (though deplored) was the fact that women must make conscious choices about life style and commitments in ways rarely required of men entering the profession. The need for, and present rarity of, female role models within medicine was recognized as a problem in this context as well as in recruiting females to medicine.

Other issues were touched on, though more briefly. These included lack of access to skills (e.g., to shop classes in junior high limited to males) and lack of access to informal information networks (e.g., information regarding availability of foreign medical schools).

Even briefer mention was made of ways to modify the present situation. Another conference with that as its primary purpose was thought desirable.

7. Creativity in Women Mathematicians

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Background

The Institute of Personality Assessment and Research (IPAR) has a rich body of data obtained from a sample of 46 women Ph.D.'s in mathematics—information about their life history, work style, personality characteristics, interests, and the way observers saw them in social interaction during assessment weekends. There are also data about 63 male mathematicians, gathered in a study originated by Richard Crutchfield, and I shall refer to this sample for purposes of comparison.

In the investigations of mathematicians, our primary focus was on creativity, and in particular, whether creative individuals had personality traits that distinguished them from others. In the study of women mathematicians creativity was assessed through ratings obtained from fellow mathematicians in the same field of specialization. The ratings were made on a 7-point scale, a rating of 4 indicating that the work of this individual was about as original as that of the average research paper published in a mathematical journal.

When it was necessary to make a cutting line, the creative group was defined as consisting of women whose work was rated clearly above average—above 5.0. Thus defined, the creative women were compared with other women, and comparisons were also made between men and women.

Comparisons of Creative vs. Comparison Subjects

The outstanding result of the comparisons of creative women with other women mathematicians was the striking difference in personality between the two groups. The creatives had strong symbolic interests, were introverted, original, and independent. The comparison subjects were much more orderly and conventional. Intelligence and specific cognitive abilities seemed less important than the differences in personality. (See "Women mathematicians and the creative personality" by Ravenna Helson, *Journal of Consulting and Clinical Psychology*, 1971, 36, 210-220.)

Comparisons of men and women mathematicians showed that the less creative men and women were more similar in personality than the creatives. Where the creative men had more initiative and assertiveness in their research style than other subjects, the creative women were inner-oriented and low in assertiveness.

Comparisons of mathematicians and authors of fantasy for children (a field to which men and women have contributed on an equal basis) showed that the style of the creative women mathematicians resembled that of the creative writers of both sexes. The creative women mathematicians were not complete mavericks, then, but why were the sex differences in creative style greater among mathematicians than writers?

There was ample evidence that one factor might be differences in environmental press, which were much greater for mathematicians than for writers. The creative male mathematicians had responsible, prestigeful positions at high-pressure institutions, where few of the creative women had contact with graduate students, one third had no regular job, and half had young children to take care of.

On the other hand, such facts did not refute the hypothesis that there are two primary creative styles, one high in ego-assertiveness and the other low, and that although some men incline to the first and others to the second, most women show the low-assertive styles. If the low-assertive style is not appropriate for mathematics--as long as such sex differences exist, are creative women doomed to a low level of visibility in this field?

The Study of Subgroups

Pressing for further clarification of this issue, we have undertaken a study of individual differences in work style among mathematicians, hoping to discover factors related to the adoption of different styles within each sex. The instrument for studying work style was the Mathematicians Q Sort, consisting of 56 items which the mathematicians sorted in a forced normal distribution according to how characteristic or uncharacteristic each item was of their own research and professional style.

Two main dimensions of variation in descriptions of mathematical style had to do with (1) orderliness vs. an emotional, disorderly attitude, and (2) confident inventiveness vs. constriction and inner focus (Table 1). Creative mathematicians of both sexes score lower on the first dimension, and men, especially creative men, score higher on the second. A graph of scores on the two dimensions shows that few men score low on both, few women score high on both, and most subjects rated low on creativity, regardless of sex, score high on order and low on confident inventiveness. Analyses beyond this point have been confined to women.

Among women, four subgroups were identified in three of the quadrants (the sparsely populated quadrant of scores high on both dimensions being disregarded). Three of the groups were about equal in creativity, and the fourth consisted entirely of women rated below average in creativity.

As one might expect, the several groups, in describing their work style by means of the Mathematicians Q Sort, place different items highest (Table 2). The women low on orderliness and high on confident inventiveness (Group I) emphasize their excitement, curiosity, and pleasure in working in a "messy terrain." Members of Group II, low on both orderliness and confident inventiveness, describe themselves as emotionally involved with their own work, and as feeling discomfort or inadequacy in relation to the outside. Group III, high on orderliness and low on confident inventiveness, expresses a preference for elegant and exact solutions, along with a combination of narrowness and inquiringness. The women rated below the mean on creativity (in the same quadrant as Group III) are less interested in research than the other groups.

On personality measures, the groups show themselves to be very different. For example, on the Adjective Check List, Group I has a peak score on "Autonomy," Group II on "Abasement" and Group III on "Order." The low creative group also has a peak on Order, but much more extreme.

What the women of these several groups are like may be illustrated by means of the sketches written by personal history interviewers. For example, here is the sketch of a woman whose research style is low on both orderliness and confident inventiveness:

> This young woman is lucid but sparse in discourse, quiet, gives an impression of great depth of character but also of slight chronic depression. She admits to playing the piano and oboe but claims no ear for music; paints but has no talent; has no facility with languages but speaks three fluently...In spite of her diffidence she seems quite strong-willed. She is certainly independent and original. She seems ambivalent about children

> and marriage, and expresses the thought that she might better have been a boy. I judge her intelligence to be exceptionally high.

And here is a woman whose research style was high on orderliness and low on confident inventiveness:

> A somewhat stiff, serious, but not unfriendly woman with a trace of girlish appeal in a generally unfeminine person. Her life is organized almost entirely around her work as a mathematician and teacher and her career means far more to her than any possible appeal that a husband and family could have. She is unconcerned with issues beyond her immediate personal life. She has unusually strong emotional needs for planfulness, order, certainty, symmetry, and logicality. Still, she is not without self-insight, and has a pretty good idea of the forces that have shaped her life.

Demographic Characteristics of the Subgroups

The subgroups differ in both family background and current life situation. Group I and the low creative group are both predominantly Protestant, Groups II and III predominantly non-Protestant. In the first two groups the fathers and mothers had about the same education, and the fathers tended to be in business or the lesser professions. In Groups II and III the fathers were professional men, better educated than their wives. The psychological significance of these and other background findings takes a much more complete presentation of the results to elucidate. Nevertheless, the relationship between the confident inventive style and a Protestant background, among women, is thought-provoking and deserves further study.

There were several large differences among the groups in life situation at the time of testing. For example, the low creative group was the least encumbered with young children: 75 percent were childless. On the other hand, members of Group II were the youngest of the sample and 70 percent of them had children. It would be of much interest to know to what extent the "Abasement" of these women was related to the predicament of wanting very much to do mathematics at the same time that they were mothers of young children. Their personality would make them particularly vulnerable to this type of role conflict, and perhaps to the pressures in the 1950's to have children.

Final Comments

Within the group of highly intelligent, introverted individualists who are women mathematicians, we have identified three distinct subgroups among those most dedicated to research. It would appear that women can pursue mathematical research with a variety of personal motivations. Some seek adventure and autonomous achievement, some work out relationships in an emotionally significant context, some want the beauty and security of elegant order. Male mathematicians appear to have the same motivations, though they show the second pattern less frequently than women do, and they more frequently combine a need for autonomous achievement with a need for order.

Each of the groups would seem to have its particular strengths and weaknesses. Group I includes several mathematicians who publish a great many papers. Members of this group have a style that is common among creative male mathematicians, and as it is also an outgoing one, they have certain advantages in communication. However, some of them do not "adjust to the feminine role" because of their needs for autonomy, achievement, and aggression. Others are so adaptable that their career remains more modest than it might be. Perhaps their need for autonomy is stronger than their need for recognition by colleagues, which may be simply to say that their careers have not been easy to incorporate into the male work world.

Members of Group II often have a very deep absorption in mathematics. They also have a social charm that helps them in interpersonal contacts. On the other hand, their feelings of unworthiness and guilt deplete their energies, and sometimes get them into situations—or prevent them from getting out of situation—that are counterproductive. The male academic world is not easy to combine with their commitments as wives and mothers and their needs as individuals of inner emotional intensity.

Members of Group III sometimes manage well in academic life, where their orderliness and rationality are very useful. Sometimes extreme introversion is a handicap. If the need for control becomes excessive, their creativity may suffer and their enjoyment of research may diminish. The core comparison group—male and female alike—has many members whose defensive mechanisms tend to stifle their research careers. Sometimes they are excellent teachers, or valuable in the organizational aspects of mathematics.

Discussion

One question concerned how the creative women combined their families and their research. The answer was that they tended to subordinate everything else to these two interests.

Another question was whether the creative women often reported getting ideas from the unconscious or with one foot upon the step of the streetcar, as described by Poincaré. The answer was that in a variety of ways the creative women described thought processes that were less conscious and deliberate than those of the comparison women.

The main topic of discussion was what to do with young women who were talented but lacking in confidence. The type seemed well known at all educational levels. We concluded with the hope that women could be made more confident but also that environments could be made more hospitable to the low-assertive creative style, and to women mathematicians generally. Had we known it at the time we would have cheered the election of Julia Robinson to the National Academy of Science.

Table 1

Clusters of the Mathematicians Q Sort

for 109 Men and Women Mathematicians

Oblique factor coefficient	Cluster I
.65	Is neat and orderly in his habits and manner of work.
-.49	Enjoys the freedom of working in a messy terrain.
.48	Has an active, efficient, well-organized mind.
.47	Prefers to get miscellaneous chores out of the way before settling down to research.
-.38	Feels emotionally tense when a result becomes imminent.
	Cluster II
.75	Work is characterized by inventiveness and ingenuity.
-.71	Lacks confidence; is afraid to strike out in new directions.
.49	Is flexible and adaptable in his thinking; able to shift and restructure easily.
-.48	Does not work on problems known to be very difficult.
.42	Reacts quickly to research problems; immediately generates a great number of ideas.
-.40	Research interests lie within a rather narrow range.
-.39	Research problem is more likely to originate in attempt to extend known proofs or results than in attempt to clarify a nebulous area.
.37	Work is characterized by intuitive power.
-.35	Easily distractible; tries to secure optimum conditions for concentration.

Table 2

Professional Style of Four Groups of Women as Assessed by the Mathematicians Q-Sort

	Mean Placement (5-point scale)
Items placed highest by Group I:	
Feels emotionally tense when a result seems imminent.	4.2
Enjoys the freedom of working in a messy terrain.	3.9**
Has a lively sense of mathematical curiosity and inquiringness; a desire to know and understand.	3.8
Items placed highest by Group II:	
Research interests lie within a rather narrow range.	4.7**
Finds it difficult to read the works of others and prefers to spend her energies on own work.	4.4**
Feels emotionally tense when a result seems imminent.	4.0
Is somewhat deficient in command of basic sources and technical literature in the field.	4.0
Takes an esthetic view; is sensitive to matters of form and elegance in research problems.	3.9
Lacks confidence; is reluctant to strike out in new directions.	3.8
Items placed highest by Group III:	
Prefers to work on problems which lend themselves to elegant and exact solutions.	4.2
Research interests lie within a rather narrow range.	4.1
Has a lively sense of mathematical curiosity and inquiringness; a desire to know and understand.	4.0
Items placed highest by Core Comparison Group:	
Has a need to teach; enjoys instructing and working with students.	4.4
Takes an esthetic view; is sensitive to matters of form and elegance in research problems.	3.8
Research problem is more likely to originate in attempt to extend known proof or results than to clarify a nebulous area.	3.8
Prefers to get miscellaneous chores out of the way before settling down to research.	3.8
Can imagine enjoying work other than mathematics.	3.8

** $p < .01$ (*t* test for difference between group indicated and Core Comparison Group)

8. WHY AND WHEN YOUNG WOMEN GET DEFLECTED FROM SCIENCE.

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To form the basis for our discussion today, I should like to report the N.S.F. supported study I have recently completed, and its findings.

This study involved 500 young women enrolled in their senior year in eight high schools in six San Francisco Bay Area Counties. These young women were selected for their aptitude in math and science, scoring in the upper twenty percent nationally on the Mathematics Section of the PSAT, in 1973, or their junior year in high school. They were matched with 102 young men. Both groups were questionnaire surveyed and twenty-seven of the young women were interviewed. Questionnaire data were secured from the staffs of each of the secondary schools participating.

A composite criterion of science-boundness was developed and both the experimental and control groups were divided into science-bound and non-science-bound groups to determine in so far as possible factors encouraging and discouraging science direction for high science aptitude people.

Generally, these young women studied in this particular geographical area seem to have come a long way, with perhaps still some way to go. They are heavily career oriented, to the extent that only one single young woman suggests that among other options she may consider that of housewife. Of these young women, 75.8% intend to work regularly in the future, too. Life style is considered of most importance in knowing about future careers, a shift from previous findings that occupational requirements were primary. Also, a sign of the times. Few attribute obstacles or deterrents to the fact that they are females, and some have the opinion that by the time they are ready for employment in the science-math-technology fields their sex advantage will no longer be viable. Social attitudes are on the change!

Some basic psychological truisms, easy to lose sight of, are reinforced in this study. One is continuously impressed with the individual differences in the forces bearing upon personal development and choice. The myriad of interacting forces, influences, accidents constitute the confusing complexity which underlies the evolution for any individual of her, or his, destiny. The strands which can be extracted for viewing are not independent, but are those which can perhaps be acted upon and may thus affect the whole to greater or lesser extent.

Another truism receiving abundant reinforcement in this study is that science and mathematics are not bound closely to each other in terms of interest and success, if not abilities. There are two axes on which they operate: from intense like of one and dislike of the other to the reverse, and intense like of both to dislike of both. Interest in science was expressed by 67%, in math 52%. Among these young women approximately one-third are at this time science-technology-mathematics-bound; only fifteen percent in present choices totally eliminated any consideration of science. With the known instability of choice at this stage, fluctuations may be expected in the futures of these young women. Experience has shown that there is apt to be attrition in the college years. However, in this group, with practically forty percent undecided, accrual may also be expected.

There are significant differences within the four groups: Science, Science-Math, Math and Other, and between the first three and the fourth. The young women who are into both Science and Math are the strongest in ability and perhaps in the assurance they will reach their objectives. The Science group is less interested or disinterested in Math, and the Math group returns the compliment for Science. Science-bound is much the largest group, and shows preference for biological sciences.

One interesting finding in contemporariness is the shying away from contemplation of teaching, and eyeing of business administration.

There are general as well as special factors that affect in differing degrees the science-boundness of young women:

Ethnicity
Distinct differences exist between the Caucasian and Asian groups which accord with previous findings. A much higher proportion of Asian young women exists in the sample than would be expected in the population, and a higher proportion were science-bound, though not math-bound. The Asian young women expressed less disinterest in math, and more intention of continuance in the study of mathematics. Over half of the Asian young women declare their intent to prepare for a future in Science, while only something over one-third of the Caucasian young women do so. Whether these differences are hereditary,cultural, environmental, they exist. As has elsewhere been indicated, recruitment of women into science in the Asian community should be profitable. In view of the lesser financial resources available to many able members if this group, increase of scholarships and other forms of financial aid especially designed for the encouragement of Asian young women for science at college undergraduate as well as graduate levels might well be considered.

Sex
Frequency of science-boundness is clearly greater for the young men, especially so for espousal of math. The young women are more likely to favor biological sciences. The young men's greater interest and strength in math appears in a number of contexts, from the distribution of PSAT scores on a national basis, to the higher scores of this group, to the stated intentions of continuing to take courses in math, and greater declaration of interest. Like the majority of findings in this study, this one is in accordance with the literature. Since the divergence between sexes increases with age, early attention to young women's arithmetic and mathematical affinity is, of course, indicated.

In the main, many similarities exist in attitudes, outlook and evaluation of their experiences. Few subjective statements speak positively to the major question: Are the problems, difficulties, and obstacles encountered by the young women sex-related, or conversely, is special encouragement received? Most responses of duplicate items are essentially similar with a few notable exceptions.

The question of sex differences in nurturance is professedly an open one. In this study of beginning senior year secondary school students, 26.3% of the young women to 1% of the young men spontaneously expressed their intention of working with children.

A puzzling finding is that more of the young men's fathers are employed in physical science and technology occupations; more of the young women's in biological sciences. Since the groups were selected for aptitude rather than intended direction there is no suitable explanation immediately available, and further research is suggested.

Community
Community and environmental factors have a bearing on the development of science-technology-math interests. Rich resources of a university town, or a large metropolitan area offer stimulation through lectures, demonstrations, extra-high school courses, speakers available to the school, participatory voluntary and work experience activities. In a heavy industrial area, community mores encourage the image of and value for technology.

Because of the young women's overwhelming responses that they want, in the process of career development, to learn about occupations through their direct active experience: seeing, observing, hearing from people involved, and trying out, schools might well be advised to amplify their efforts in behalf of their students to bring the community closer to them, and to be closer to it. In all communities resources are to be found, and the effective community may be larger than the school's district. Special attention could well be given to the science-technology-mathematics area in offering early and continuing opportunities for exposure and participatory activities.

Parents and family
The parents of this study's especially capable young women are also superior, educationally and occupationally. Two-thirds of the mothers are currently employed. Unquestionably, the parents are very important influences, especially the father, who is the more important in relation to science for the young women and even more so for the young men. It is the father to whom the child ordinarily turns early for help with homework in arithmetic and later for math, and his patience or impatience may be crucial in both attitudes and achievement subsequently.

The parents aspire high for these daughters, principally educationally. Interestingly, of those who have designs for them occupationally, it is the father who is apt to conceive of science areas, and it is more apt to be the mother who prefers female sterotypic roles for her daughter.

The family interests affect the early aspects of career development, often positively, sometimes negatively. The family's love of nature, value for mathematical processes, curiosity about causation has its impact, especially when it is implemented with communication, and with experiential outings. Occupations within science areas transmit directly.

Siblings, particularly older ones, are also influential.

Educational practices
There is nothing particularly new in the findings in this area, but this study reaffirms the major significance of the educational experience in career development towards sciences.

a. Curriculum
There are suggestions, particularly in the interviews, that the science curriculum prior to secondary school has not been well conceived. It appears to be haphazard in nature, with sporadic

"units" of science introduced irregularly in the elementary school. The "general science" course, at least in this geographical area, varies considerably in relation to the particular interests and training of the teacher. It may concentrate on one aspect of science, or several, or treat all lightly. Unlike the majority of school subjects, there appears not to be an established sequence and exposure throughout. Attention might well focus on elementary-junior high school organized curriculi, with study of optimal time and content presentation. It would appear that curriculum in the secondary school can most profitably be expanded to include field experiences in the sciences studied, e.g., rotating hospital internships.

b. Courses

Courses were stated to be a major influence, ranking third. Continuous reference is made by the young women in the study to the content of their courses, and the importance of the method by which material is presented. By these able young women discovery and full comprehension are preferred to rote, and they are attracted to appropriate content. Relative difficulty of math-science courses was frequently indicated, and supported by differential grading for these top math-science aptitude students.

c. Teaching

As is well known, teaching is crucial. Presentation of material, competence in grasp, and communication, relating to students and their level is essential. The young women are aided in being attracted to math and science if they understand their relevance to the world, and life, and their utility for the present and future. Good experiences may sometimes be weathered. Sometimes poor teaching at a critical juncture turns the young woman away from math particularly, once and for all. Without an adequate "background" she may founder later, even if she is willing to try. There is linkage in this study between strength of educational preparation of teachers and science-boundness by school. The sex of the teacher was rarely considered important, but rather the competence regardless of sex. The science and science-math groups complain more about poor math and science teaching, especially of math before high school by the science group.

d. Grading practices

There is some evidence that grading practices may be related to career development of able students at either extreme. Too easy overall grading prevents the students from self-knowledge for self evaluation of abilities and interests, and retards differentiation of fields. On the other hand, too stringent grading tends to discourage and prevent a realistic appraisal of knowledge and strengths.

Social Science and English grades were higher for the science-bound group than their science and math grades, supporting their statements both of difficulty, and also the attraction of that difficulty.

e. Guidance practices

Notable is the young women's stress on self-activity in career development. Attention to enlargement of work experience opportunities in scientific areas would be of major help, as would be focussing on obtaining speakers for in-depth discussions with students. Arranging field trips in lieu of actual work experience might also be an increased function of the guidance program. Such experiences as these mentioned above are the preferred methods of evolving "own interests" and considered more helpful than hearing about career from school personnel. It is rather notable that these young women rarely knew much about the school's Career Centers, or expected their counselor to be helpful in career planning other than in college selection.

Attributes

Overwhelmingly and in every context, the young women attributed the greatest influence in career direction to their own interests, and their own abilities. These, of course, have been in the process of being shaped by the plethora of factors mentioned, among others, and the complexity of their interaction. They are an achieving group, having grades which would admit all but 5.4% to the State University directly, and the others would be admissable on the CEEB. The young women's aspirations for their education were very high, and in excess even of their parents' aspiration for them, and resembled their fathers' educational level. Their aspirations are far beyond those of their mothers for them.

These young women's ambitions are seen, too, in their evaluation of their scholastic achievements, professing greater dissatisfaction than their parents.

There are personality attributes which significantly distinguish the science-bound from non-science-bound in the case of the young women. These preferences are to:

- Solve puzzles and problems
- Take things apart and see how they work
- Do things that will improve society
- Do things independently of others

They indicate less preference for working with children than do non-science-bound young women. These particular findings suggest native factors as well as the external encouraging and discouraging ones.

Stability'

As has been indicated throughout, there is considerable uncertainty about stability of choice or even direction at as early a stage as these young women and young men have been studied. Considering the extensiveness of the data accumulated concerning them, it would seem highly fruitful to follow these young women, particularly in their later exposures and experiences. The second year of college, the fourth, less intensively, and the second or third thereafter would seem to be specially advantageous points at which to sink shafts: shafts of inquiry, testing, objective evaluation of course of action and performance, to be related to the data accumulated in this 1975 study.

9. MATH AND SCIENCE ACTION PROGRAMS FOR YOUNG WOMEN

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The education of young women toward scientific and technical fields is one way to expand women's economic roles and to close the earnings gap between the sexes. Women in 1976 remain concentrated in low-paying, dead-ended jobs, primarily in traditional female fields of teaching, nursing, social work, and clerical services. To encourage their entry into male-dominated careers in mathematics, science, and technology, an early effort to prolong their math lives is essential.

Avoiding mathematics in high school creates formidable obstacles to the later choice of a career, not only in science and technology, but in business, banking, accounting, and even law. Yet, most high school women do not take enough math and science in high school to prepare for these occupations (College-Bound Seniors, 1975; Sells, 1973).

While a poor mathematics background is a critical filter in the job market, it is also a hindrance to intelligent participation in society. Analytical skills and mathematical confidence are required for wise decisionmaking in purchasing, banking, investing, computing taxes and insurance, completing business transactions, and interpreting the myriad statistics which bombard us daily.

At the Lawrence Hall of Science, we have been devising programs to increase elementary and high school women's interest in math and science.

As a public science center, and research unit in science education at the University of California, Berkeley, the Hall provides activities and exhibits to increase the general public's understanding and awareness of science. As part of this effort, after-school classes for children, ages 6 - 16, are offered in the physical and life sciences, mathematics, and computer science. In 1974, we surveyed these classes and found that female students accounted for less than one-third of the enrollment. We reasoned that, if female attrition in the sciences begins as early as age six, it is not surprising to find less than one percent of them as engineers 16 years later.

In developing programs to reverse this trend, we began by asking several questions: When do sex differences in mathematics achievement first appear? Why is it that women "turn off" from mathematics in much greater numbers than men? What are the special needs of young women studying mathematics?

Hilton and Berglund's longitudinal study of sex differences in mathematics achievement (1974, p. 234) found no sex differences in achievement at fifth grade, but ". . . at subsequent grade levels (7, 9, 11) males have higher mean scores than females and the differences increase with age." Findings reported by Maccoby (1966) and Mullis (1975) provide further evidence that sex differences in mathematical reasoning and spatial visualization abilities increase in favor of males throughout the junior and senior high school years.

Why Women Avoid Math

Several recent studies have attempted to determine the reasons for these differences (Casserly, 1975; Kirk, 1975; Haven, 1972). It appears that even many high-ability young women have a variety of negative attitudes toward mathematics, which deter them from prolonging their math lives. These include a general lack of interest in math; a lack of confidence in their ability to do well in mathematics; an inability to see the relevance of math to their present or future interests; and stereotypic beliefs that math is an inappropriate pursuit for females, or that others will view it as such.

How do these attitudes develop? What factors have influenced young women who do choose to pursue math and science throughout their educational careers? Researchers point to parents, teachers, counselors, and peers as influential in the decisions, activities, and views of these women (Casserly, 1975; Haven, 1972). Attitudes toward math and science may be influenced by the kinds of toys and games provided by parents. Astin (1974) found, among a small sample of parents of gifted children, that boys were more likely to receive science kits, microscopes, or telescopes than girls. Kirk (1975) found, among high-ability young women, that those who were "science-bound" were significantly more interested in puzzles, taking things apart to see how they work, and problem solving than were those who were not science-bound. Failure to provide girls with activities that stimulate inquiry and investigation may restrict early curiosity in problem solving and risk taking, so essential to the development of mathematical and scientific interests and abilities. Matthews (1975, p. 8) notes that "By the time elementary school days begin girls may be locked into behavior and reaction patterns that are so restrictive of the expansion of the mind that special types of education are needed to thaw out potentiality and encourage the exercise of competence."

Parents may influence students' mathematical abilities in more subtle ways as well. Ernest (1975) and Kirk (1975) note that students turn to their father, not their mother, for help in mathematics, particularly in high school. Parents can serve to reinforce the notion that math is a masculine domain, or can encourage their daughters to develop their mathematical abilities and to have high aspirations in their educational careers.

Teachers, counselors, and peers often perpetuate stereotypic beliefs that women don't need to study math, that boys are better than girls at math, and that women couldn't or shouldn't become scientists or technicians. Ernest (1975) found nearly half of the elementary and secondary school teachers he questioned were convinced that boys are better at math than girls. Many of the talented high school women studied by Casserly (1975) reported having been discouraged from enrolling in advanced science and math courses by their guidance counselors. In some instances the counselors felt that advanced math wasn't necessary for college; in others, that it was superfluous for girls, perhaps even damaging, as a counselor in her twenties remarked: "I just hate to see a girl get in over her head. I always try to place students at a level where I know they'll be successful. I mean, wouldn't it be frightful to spoil a beautiful record by doing poorly in a course your senior year."

Action Programs

What can be done to eliminate sexism in mathematics training? Kirk (1975) stresses the need for early and continuing opportunities for girls' exposure to and participatory activities in mathematics, with attention to relating the content of learning to the student's present and future lives. Casserly (1975) sees sensitizing counselors, teachers, and parents to the necessity of desexing career expectations by encouraging all eligible girls and boys in early junior high school to accelerate in mathematics, even if the students' interests in math and science seem vague and undefined. Both researchers would encourage older girls who have been successful in high school math and science to discuss the opportunities and advantages of pursuing these courses with younger girls, and providing women in the field as similar resources. These female role models might serve to reduce the seeming inappropriateness of math and science as fields for women, and provide support and encouragement often missing in young women's educational environment. Fox (1976) has provided some evidence that teaching accelerated math classes to bright adolescent girls is more effective in an all-female environment than in a coed setting.

Combining many of these recommendations, we have been offering "Math for Girls" classes at the Lawrence Hall of Science for the last two years. Our enrollment is drawn from girls, ages 6 - 14, with varying backgrounds and interests, who come once a week for eight weeks to the class.

Math for Girls is taught by women students at the University of

California, Berkeley, who are majoring in mathematics, mathematics education, or computer science. They are selected and trained on the basis of their interest and ability in mathematics, and their desire to act as role models for their students. Throughout the eight weeks, time is set aside for discussion of girls' competency and interest in mathematics, and the stereotypic attitudes that can result in limited career expectations for women. The importance of electing science and mathematics courses in high school is stressed.

The curriculum focuses on problem solving. Puzzles, games, and activities are used to show a side of mathematics that is as fun as it is challenging. Students are helped to look for fundamental concepts and relationships in mathematics, such as numerical and geometric patterns; understanding variables and functions; strategically organizing information; classifying into sets; using coordinate systems and graphing; estimating; and visualizing spatial relationships. A discovery-oriented approach is used--students are encouraged to generate a variety of ideas and are helped to concentrate on those that are most useful. Among the manipulative materials used, there are commercially available products such as geoblocks, geoboards, attribute blocks, pattern blocks, and topological puzzles.

Since Spring 1974, when Math for Girls was first offered, 300 girls have taken the course and the total number of females enrolling in other Lawrence Hall classes has doubled. The following comments provide some idea of the diversity of attitudes of those who have participated in Math for Girls.

Some students had difficulty seeing the relationship between problem-solving activities using manipulatives and the math they do in school, thus:

> "I thought the course was going to help me with the math I do at school, but it didn't."
>
> "The course should have been more related to school. We played too many games."

But for others, their view of mathematics had been broadened, as we had hoped:

> "I have become aware that there is more to math than equations and quadratic formulas."
>
> "I never really knew until now that you could learn by games."
>
> "The class expanded my mind and made me feel more comfortable doing any problem set in front of me."

Whether the all-female environment made a difference varied for respondents; some felt indifferent or ambiguous:

> "It doesn't matter to me if there are boys in the class."
>
> "I have mixed feelings about boys and girls together, and I'm not sure how I feel."

But many indicated a preference for this setting:

> "I thought that the idea of a class just for girls was a really great idea; I usually feel threatened when I walk into a math class, and when I'm in a class of just girls, I don't feel put on the spot."
>
> "I liked it better since it had just girls in it because the boys are always saying, 'This is so easy.'"
>
> "I like a math class especially for girls because I'm not as worried about making mistakes."
>
> "I'm glad the class just had girls in it, but now if the class was to contain both boys and girls, I would take it again anyway."

The Math for Girls classes represent our first attempt to provide positive experiences in mathematics for young women, but they only reach a limited number of girls, primarily those able to afford the tuition to take the course. We have become increasingly interested in finding other methods of stimulating awareness of and interest in careers that are math and science-related, and of reaching more young women in these efforts.

"Expanding Your Horizons," a conference on the Mills College campus in March 1976 for 200 young women, was our next effort. Sponsored by Mills, the Lawrence Hall, and Alameda-Contra Costa Counties Mathematics Educators, the conference was the result of 54 women scientists and mathematicians from elementary schools, colleges and universities, and corporations who donated their time to provide workshops for students and adults.

The seventh- through twelfth-grade students who attended the conference were recruited by their high school math teachers, parents, or other school personnel. The format of the conference included a panel discussion in the morning, consisting of an engineer, a statistician, a biologist, a mathematician, and an undergraduate in engineering. Each of these women described the challenges and problems of their work, from a personal perspective. Following the panel, students attended math workshops that emphasized active participation and experimenting. There were activities in topology, probability, estimating, and statistics. Students in one workshop constructed a hypsometer and then made estimations of the heights and distances of campus buildings.

After lunch, students attended science workshops, participating in activities in microbiology, optics, chemistry, marine science, computers, and astronomy. They had an opportunity to question women working in these fields about their day-to-day experience, and they evaluated the conference.

Throughout the day, workshops were held for parents and teachers who had accompanied the girls. These focused on discussions of the history of women in mathematics, media presentations of images of males and females in elementary school textbooks, analyses of programs to reduce sex stereotyping and increase career options for young women and, most popular, information about entrance requirements to Mills College and University of California, with special emphasis on scholarship opportunities. The inclusion of the workshops for adults was important; they were able to acquire practical information to help them assist their daughters and students in pursuing math and science interests, and it allowed the math and science workshop leaders to concentrate exclusively on the students.

Evaluation data collected from 148 students provided useful information. Overwhelmingly, the science workshops seemed the most valuable to students because they could see the relationship between the activities they were doing and the work of scientists. This was not true for the mathematics workshops. Once again, the students were disturbed because they were unable to relate problem-solving activities to mathematics. Our experience in the Math for Girls classes was reinforced. Many students cannot accept that this is "doing math" since it is so far removed from the mathematics they are used to in school. The older the student, the more resistant she seems to be to seeing that mathematics is a process for solving problems and developing logical thinking abilities, rather than merely finding the right answer to a question. Unfortunately, this very reluctance to view mathematics in a wider perspective makes the subject less relevant to the student's daily life and may prevent her from developing interests in math applications. It may also have much to do with her perceiving math as boring, mystifying, or threatening. Clearly, this is an area that requires much attention for those of us who are interested in finding ways to attract young women to mathematics.

We tried to find out if the conference had changed students' attitudes about math or science in any way. We found that, in this group of highly motivated young women, many were already considering careers in these fields and that the conference served to reinforce their decision. But many remarked on the importance of women role models and the diversity of career information they received at the conference. Several comments reflect this:

> "It made me realize a little more how women really can add immensely to any scientific or mathematical field."
>
> "It made me feel more informed and more sure about what I want to do."
>
> "I don't feel quite so alone in my aspirations."
>
> "I know there are challenging courses and I want to be one of the great women able to conquer them!"
>
> "I now realize that I can (if I'm still interested) some day get a job in math or science. Before I had no idea what jobs would be open, and if they would be any fun."
>
> "The conference has helped me to be more sure and determined of myself as a woman in a professional career, despite any conflicts that arise."
>
> "It felt good to see and hear from women who are into math and

> science who enjoy their work and are supportive of women entering those fields."

> "It was very good for me to see so many professional women in what I usually think of as careers that are totally male. It changes my opinion of that career at a much deeper level than if someone had just said to me, 'Yes, it is possible for women to go into that field.' To see is to believe."

Taken together, the evaluation comments provided us with ideas for improving future conferences: combining similar ages into workshops, allowing more time for small group discussions, providing women from a greater variety of scientific fields, and preparing informational handouts about scientific careers and the educational preparation required for entry.

Future Plans

Many areas are still in need of attention if we are to eliminate sexism from mathematics. As Fox (1976) points out, even if we remove external barriers, such as sex discrimination in hiring, women will not automatically surge forth to fill the ranks of scientists. Efforts must be focused on programs for parents and other school personnel, as well as students.

We see a new cooperative effort among women scientists, mathematicians, technicians, and educators flourishing in the San Francisco Bay Area. To maintain the momentum of these efforts and strengthen the cooperative network a consortium model is proposed. The consortium would include elementary and secondary schools, colleges and universities, and corporations interested in motivating young women toward careers in science and technology. It would exist as a coordinating center within a local educational agency and have the following components:

1. Materials/resource/information center, including facilities for student activities;

2. Teacher education center, providing inservice and preservice workshops;

3. Research center, linking researchers with practitioners and generating on-going research studies;

4. Dissemination center, providing a mechanism to publicize the consortium's activities and facilitate the outflow of materials to participating members;

5. Evaluation center, conducting formative and summative evaluation studies.

The programs developed by the consortium would provide both materials and direct services, and would be available through the consortium to all participating agencies. With funding for such a consortium, several projects could be implemented immediately:

MATERIALS

A career guide describing the hundreds of careers in science and technology, with personal statements written by women in these occupations, and educational qualifications specified. This guide speaks to the seemingly total lack of information appealing to high school women about the variety of work they might engage in if they have adequate science and mathematics preparation in high school. While the guide will be focused toward students, it will be used by counselors, teachers, parents, and administrators.

A sourcebook for math and science teachers, counselors, and parents, which will provide resources, information, and suggestions about initiating discussions and projects designed to create an awareness of sex-role stereotyping, and its effect on future career expectations of young women. Such a sourcebook is particularly needed for math teachers since it is these teachers whom female students identify as being the most helpful or discouraging in their own decisions to pursue mathematics in high school.

A mathematics enrichment guide for use by teachers in grades 6 - 8, which will set forth the strategies, materials, and content to enable them to implement a mathematics enrichment program, similar to those offered at the Lawrence Hall of Science.

An activity book for students in grades 3 - 6, called "Women in Science and Mathematics." The book will convey information about women throughout history who have made significant contributions in scientific and mathematical fields. In addition to the biographical information, the book will include activities and simple experiments that students can do on their own, which will relate to the women's fields. The graphic element will include pictures to color that show the women at work, so that students will be provided with visual keys to the professions.

DIRECT SERVICES

One-day conferences at Mills College, each reaching a total of 200 seventh- through twelfth-grade young women, to promote awareness of opportunities for women in science and technology. The conferences would follow the format of the pilot conference held March 1976 at Mills, but would be revised in response to suggestions from the evaluation data.

Workshops conducted by high school students to encourage their peers and younger women to continue their studies of math and science throughout high school. Workshops will be designed to promote awareness of career opportunities for women in science and technology and generate positive attitudes toward women working in traditionally male occupations.

Visits by women scientists and mathematicians to junior and senior high schools to encourage young women to consider careers in science and to discuss with school personnel the need to encourage young women to prolong their math lives.

Tutoring programs for women high school students who are having difficulty in math. The program would be available during school hours (lunch time) and be staffed by women mathematicians (university students or unemployed teachers) who are sensitive to the difficulties women may have in math, and are supportive of their efforts to master the subject.

These projects are only the beginning of what we can do. They represent the practical aspects of a vision. With the help of many people interested in this work, we can create a center to educate women for full participation in fields where they have been undereducated and underrepresented for too long.

Your participation is encouraged. Please call or write for more information: Nancy Kreinberg or Rita Liff, Lawrence Hall of Science, University of California, Berkeley, CA 94720, (415) 642-1823.

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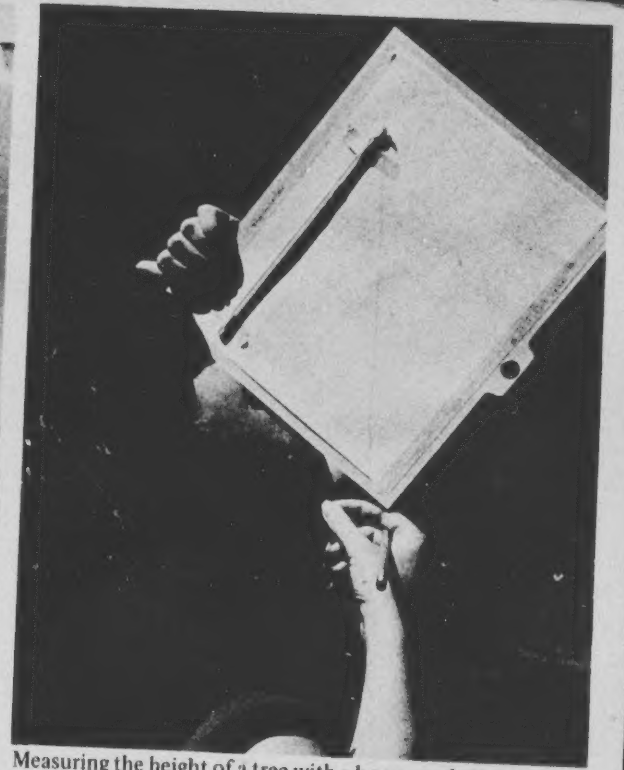


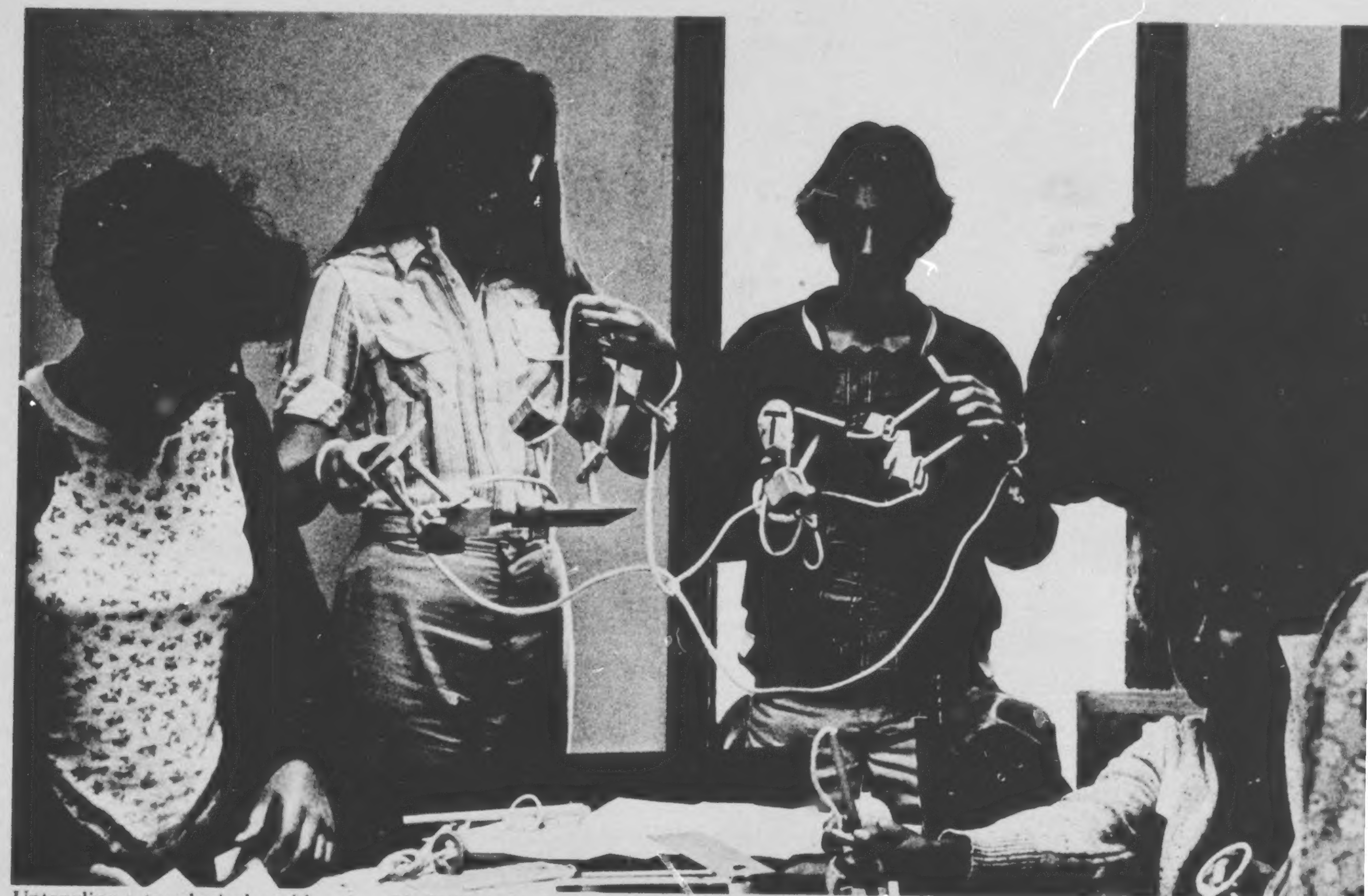
Measuring the height of a tree with a home-made hypsometer: A Math Workshop.

Building rat mazes to explore challenges similar to those faced by scientists.

"Expanding Your Horizons" Conference, Mills College, March 20,1976. Photos by Charles Frizzell.

Experimenting in salt water chemistry in a Marine Science Workshop.

Exploring strategies and games of logic in a Computer Workshop.



Untangling a topological problem in a Math Workshop.

EXPANDING YOUR HORIZONS

A conference for young women interested in

MATH

SCIENCE

TECHNOLOGY

March 20, 1976
Mills College
Oakland, California

9:30 - 10:30 WELCOME AND PANEL DISCUSSION
"Careers in Science and Engineering"
Moderated by Lenore Blum, Professor,
Mathematics and Computer Science, Mills College

PANELISTS:
Sue Denniston, student, Mills College and Stanford University
Constance Golden, Engineer, Lockheed Corporation
Elizabeth Scott, Professor of Statistics, University of California, Berkeley
Ellen Weaver, Professor of Biology, San Jose State University

10:45 - 11:45 WORKSHOPS IN MATHEMATICS
Ms. Norma Alexander, Ohlone College
Sister Madeline Rose Ashton, Holy Names College
Ms. Sue Stimmel, Lawrence Hall of Science and Ms. Carol Bastiste, Oakland Unified School District
Dr. Judith Forcada, Education Department, University of California, Davis
Ms. Heather Hubbard, Lawrence Hall of Science and Ms. Rita Liff, Lawrence Hall of Science
Ms. Arlene King, University of California, Berkeley
Ms. Carole Langbort, Richmond Unified School District
Ms. Tina Levy, Diablo Valley College
Dr. Jeanette Lockley, Merritt College
Ms. Teri Perl, graduate student, Stanford University
Ms. Fredericka Reaves, Alameda High School
Dr. Diane Resek, San Francisco State University
Ms. Twila Suttle, Lawrence Hall of Science and Ms. Diane Stone, Lawrence Hall of Science

10:30 - 3:30 WORKSHOPS FOR TEACHERS AND PARENTS
10:45 - 11:45 - Discussion of entrance requirements with Beth O'Neil, Dean of Admissions at Mills, and Karen Taylor, Department of Relations with Schools, University of California

1:00 - 2:00 - "THE HISTORY OF WOMEN IN MATHEMATICS" - Sister Madeline Rose Ashton, Holy Names College

2:00 - 2:30 - Media presentation - "BIASED IMAGES OF MALES AND FEMALES IN ELEMENTARY SCHOOL TEXTBOOKS."

2:30 - 3:30 - "EXPANDING CAREER CHOICES FOR YOUNG WOMEN - A PROGRAM TO REDUCE SEX STEREOTYPING AND INCREASE CAREER OPTIONS" A DISCUSSION MODERATED BY Judith Glickman, Contra Costa County Superintendent's Office.

12:00 - 12:45 LUNCH

1:00 - 2:00 SCIENCE AND COMPUTER WORKSHOPS

"SCIENCE: YOU CAN DO IT!" Explore challenges similar to those faced by people who do science. - Dr. Jenny White, Lawrence Hall of Science

"SCIENCE NOW" Choose from 20 experiments you can do right here. - Dr. Marcia Linn, Lawrence Hall of Science

"LET'S DO IT OUTDOORS" Investigations of aquatic animals in outdoor biology. - Ms. Linda DeLucchi, Lawrence Hall of Science

"OPTICS" Work with defraction gratings, polarization, lens, and candle flames. - Ms. Cathy Cantrell, Lawrence Hall of Science

"MICROBIOLOGY" From the laboratory to the kitchen and back again - examining biological and chemical properties of food. - Dr. Ann Norberg, Lawrence Hall of Science

"DAYTIME TELESCOPIC OBSERVATIONS" A visit to Chabot Observatory to see Venus and the Solar system. - Dr. Helen Pillans, Mills College

"FUNDAMENTALS OF LASERS" Demonstrations of how a laser works. - Dr. Sandra Slivinsky, Lockheed Missiles and Space Co.

"BATTERIES AND BOLTS" Find out about sparks that light the world. - Dr. Judith Forcada, University of California, Davis

"MARINE SCIENCE" Experiments in salt water chemistry and observations of marine organisms. - Ms. Karen Reynolds, Oakland Public Schools

"BLOOD PRESSURE AND PULSE, HEART SOUNDS, AND THE SPIROMETER" What physical measurements mean and how instruments function. - Ms. Nancy Rankin, Mt. Diablo School District

"HAVE FUN BEING A SCIENTIST" Use a variety of tools from different science careers. - Ms. Debbie White, Mt. Diablo School District.

"TESTING ADDITIVES IN FOOD" Find out what additives are and what they do. - Ms. June Anderson, Oakland Public Schools

"WORKING WITH WATER" Hands-on activities with plankton and summary of water environment studies. - Ms. Jane Helrich, Mt. Diablo School District

"CHEMISTRY MAGIC" Find out what's happening in chemistry today. - Ms. Vicky Wendell, Mt. Diablo School District

"COMPUTERS IN SCIENCE" Explore strategies and games of logic. - Ms. Flora Russ, Berkeley Unified School District, and Ms. Melanie Harvey, student, Berkeley High School

2:00 - 2:45 SMALL GROUP DISCUSSIONS
Your chance to question professional women in science and technology. Led by workshop leaders and engineers Evalyn Gratrix, Wendy Westover, Julia Lee from IBM Corporation, and Marsha Strahl from Westinghouse Corporation.

2:45 - 3:30 RECOMMENDATIONS
You share your impressions with us.

10. CAREER RE-ENTRY/UPGRADING.

Peggy Shoenhair, Staff Associate, Foothill-De Anza District
Special Projects, Office of Technical Education

Peggy Shoenhair opened the session, as she set up the slide show on the New VIEW [Vocational Internship Education for Women] Program, saying she was delighted to discuss that specific model program, but that she hoped there would be a general discussion of career-related needs of women.

Peggy spoke of the many thousands of women returning to and entering colleges and universities around the country. Many already have some college and/or work experience, but have been mostly homemakers or low-paid workers, and they want colleges to prepare them for--and help them find--more challenging careers.

Many mature women students--and mature may mean early twenties in some places--greatly need to gain self-confidence and a realistic assessment of their abilities and limitations. Straight "A's" in classes and labs aren't enough for the 45-year old woman who's never worked--she needs practical on-the-job experience!

More than meeting women's needs, or making the educational system more relevant, Peggy is interested in really opening up and changing education. New VIEW--which carefully integrates internship, academic and counseling experiences for a specific population [mature women in scientific and technical fields]--is one effort to try to provide a coherent environment for the total person, as opposed to letting her or him "wander haphazardly" through the educational system.

Peggy then introduced herself and asked the other participants to do the same. She was trained as an anthropologist, and fell into working with programs for students who wanted practical experience. Working with Sid Davidson at Foothill-De Anza, she found that women were badly underrepresented in work experience programs. Together they developed the New VIEW proposal, which was funded by Carnegie for two years.

The participants in this session were there for both personal and professional reasons. One was the secretary to a physicist at Lawrence Laboratory, another got her Ph.D. after a long struggle to support herself and her children, a third had a Ph.D. in math and wanted to work part-time or retrain in computer sciences while her children were young. Mills College's internship coordinator was present. Another woman worked as a computer programmer, but wanted to retrain in another career, perhaps as an architect. A Mills student and another woman exploring career options completed the group.

The slide show reviewed New VIEW's development, organization and participants. All internships are at the Ames Research Center, in scientific, technical and business positions. Many New VIEW students have BA degrees; they take courses at De Anza and Foothill and have counseling groups while completing their internships. The goal of the program is to help the students get jobs.

After the slide show, a memo was distributed showing eight of the first nineteen New VIEW students are employeed in career positions [this group just completed their year in the program April 2.] Four women are going on to school, four others are actively seeking work, one woman dropped out, one was dismissed on academic grounds, and one is staying home for a few months for personal reasons. Another twenty-four women are currently in the program. They are mostly in their thirties and forties.

Peggy was asked specifics about the program (Was it designed particularly for older women? Yes; Did participants receive credit? Yes) and more general questions, such as "Has there been interest on the part of liberal arts faculty in a similar program? No, but many students majoring in the social sciences and liberal arts seek internships, and we are trying to get stipend monies for a public service careers program."

Other discussion concerned the "lack of reality" many women looking for jobs feel, involving both assessing their own abilities accurately and knowing what various jobs and people are like.

A question was raised about women who want teaching careers, and Peggy replied that she frequently tries to encourage women seeking traditional careers to try other options because jobs are so scarce, four or five former teachers are in the New VIEW Program now.

The hesitance of some academicians to feel that career preparation is a legitimate responsibility of colleges/universities was also mentioned. The Mills internship coordinator reported that the Mills students getting good job offers usually have internship experience, and that women students going on to graduate school seem to have more sense of direction if they have some real-world experience.

Volunteering, in a position which may really lead to a career, may be the only way some women can get job experience, though it can certainly be an exploitative trap.

In general, everyone seemed agreed that both women and men need both academic preparation and job experience to be best prepared for careers they want.

Peggy offered the final observation that the New VIEW women are not politically activist or feminist. What unites them is a personal dedication to having a useful, rewarding career. She said that twenty years ago these women did not expect careers. Therefore it may be a hopeful result of the women's movement that many individual women now feel it is OK for them to want and strive for serious careers.

II. ADMISSION AND ATTRITION OF WOMEN IN THE SCIENCES

Lucy Sells, Executive Specialist, Women and Minorities, Amer. Sociological Society, Washington,D.C.

This paper examines available data on admission and attrition of women in the sciences. It describes two filtering points at the admissions level, and two at the attrition level.

Admission of women in the sciences

1. As recently as 1972, 92 percent of the entering first year women at a major research university were effectively excluded from admission to undergraduate majors in the sciences because of inadequate preparation in high school for the standard calculus sequence (Sells, 1975). In that year, enrollment data from the Office of Institutional Research for each undergraduate major at Berkeley were correlated with course requirements listed in the University Catalog. There was a correlation coefficient of - .65 between percentage of undergraduate majors who were women, and percentage of course requirements in the undergraduate curriculum which require the standard first year calculus sequence.

From the data, there is no way of discovering whether freedom of choice by students, or discrimination against women by departments is the primary explanatory factor. Full freedom of choice implies full knowledge of options, and of the consequences of choosing not to take as much mathematics in high school as one can handle. Conferences such as today's have an important contribution to enhancing full freedom of choice, by making options and consequences clearer to students, parents, teachers, and administrators.

2. It is clear from data at Berkeley that women are being admitted to graduate programs in the sciences in the same proportion as they are applying. The critical problem for admission of women in the sciences in graduate programs is to encourage them to apply.

Attrition of women in the sciences

1. The first form of attrition is in the drop-off in percentage of women earning the bachelor's master's and doctoral degrees in the biological and physical sciences. Part of this is accounted for by the drop-off in percentage of women earning undergraduate degrees in the sciences. Table 1, below shows the percentage of women earning each degree for two time periods, 1948-1953, and 1971-1974. The improvement over time has been greater for the biological sciences than for the physical sciences.

Table 1

Percentage of Women Earning Degrees in the Sciences,
University of California, Berkeley,
1948-1953 and 1971-1974

	Biological Sciences		Physical Sciences	
Level of Degree	1948-1953	1971-1974	1948-1953	1971-1974
Bachelor's	20% (842)	33% (1,506)	8% (660)	25% (975)
Master's	22% (186)	45% (116)	4% (195)	14% (400)
Doctor of Philosophy	12% (171)	23% (225)	4% (348)	6% (305)

Source: Compiled from Office of Institutional Research, University of California, Berkeley, Annual Figures on Degrees Granted.

Number in parenthesis is base of percentage. Read 20% of the 842 Bachelor's Degrees awarded in the Biological Sciences from 1948-1953 were women.

2. The second form of attrition for women in the sciences is the dropout rate from doctoral programs. Among the Woodrow Wilson Fellows who entered graduate school between 1958 and 1963, there were sharp sex and field differences in dropouts from doctoral programs. While 20 percent of the men in the biological sciences dropped out, 36 percent of the women did so. In contrast, 25 percent of the men in the physical sciences dropped out, compared with 59 percent of the women. These data suggest different climates of expectations about women in the biological and physical sciences.

Recent data from Berkeley show a dramatic reduction in sex differences in dropouts from doctoral programs by the fourth year. In the entering class of 1962, 22 percent of the men had dropped out by the fourth year of doctoral programs, compared with 42 percent of the women. In the entering class of 1968, 27 percent of the men had dropped out, compared with 27 percent of the women. The longstanding sex difference in dropouts from doctoral programs has been eliminated at one major research university, through changing expectations on the part of faculty, and changing levels of commitment and motivation on the part of women graduate students. These data can be used to generate future self-fulfilling prophecies on behalf of women in the biological and physical sciences, as well as in the humanities and social sciences.

12. JOBS FOR WOMEN IN SCIENCE

Presented by

Marlys C. Hanson
Manager
General Employee Training
Lawrence Livermore Laboratories

In structuring my remarks for this discussion group, I have decided to orient my comments around three basic questions that we use in the Career Planning Program for employees at Lawrence Livermore Laboratory.

The questions:

Who am I?

Where am I going?

How am I going to get there?

These are timeless questions - in that we are finding are as valid for a 40 year-old professional scientist as they are for your high school students - for the questions force us to deal with defining interests and values, making decisions, setting goals, seeking information, making commitments.

The first question - Who am I? - involves assessment of just what it is one wants from life - and what interests and abilities one possesses. As there is considerable material available on the assessment process - and it is not the subject of our discussion group - I will not dwell on this question.

The second question - Where am I going? - gets more to the point of the discussion of jobs for women in science, and there are two parts to this question - Where do I want to go? and Where will the opportunities be? In the traditional areas of chemistry, physics, biology, mathematics? Or will the opportunities be more plentiful in fields of applied science? Where are the best opportunities for women in science? These are some of the areas I will discuss.

The third question - How am I going to get there? - is where you, as educators, get into the act, and I will comment on that question briefly as I summarize my remarks.

So - back to the question of Where am I, as a student interested in a career in science - going? Where will the action be? In response, let me suggest the age old techniques of investigating resources, and then share with you some of the results of my own investigation on this subject.

Some of the resources I used were scientific periodicals/journals, literature from business/industry, and discussion with professionals in the field.

What did I find? For one thing, a great deal of discussion on the impact of energy research and development on creating jobs in various fields of applied science. Another finding was the increasing opportunities as science technicians. Let us look more closely at these items:

First of all, there are several sources of energy - solar, geo-thermal, oil, gas, coal, nuclear fusion and fission, and oil shale are probably the most important ones. I am going to talk just a bit about each of these areas - and while I am doing so, I would like you to be thinking about the kinds of jobs involved.

One of the major traditional sources of energy is coal. There are great amounts of coal in the Western U. S. - much of which could be surfaced mined, but it would create immense environmental problems. Air pollution would also be a problem in converting coal to electricity. Coal gasification is an alternative way of using the source - this means lighting fire to the coal where it is - this creates a gas, which is processed and put in a pipeline (or preferably used to generate electricity at the surface). Solution mining may be another alternative, wherein the coal is put in a solution and brought to the surface.

Oil exists in many reservoirs which require different techniques for extraction. Water flooding or sweeping is one method; using soaps or other petroleum products to emulsify oil and bring it to the surface is another technique. Explosive stimulation, using regular or nuclear explosives is used to stimulate flow, as are hydraulic fracturing methods, which involves pumping liquids into open pathways to increase flow. Natural gas is another energy resource - but in much shorter supply. Stimulation techniques used with oil are also used to get gas out of tight reservoirs.

Much research is being done with solar energy - and problems exist with low conversion efficiencies and unreliability. Geo-thermal energy has related pollution problems as minerals tend to dissolve in the hot water - the various salts dissolved in the hot fluid can be a special problem here.

Another type of energy is Nuclear fusion - the thermo-nuclear burning of heavy hydrogen in sea water. This appears to be the only unlimited source of energy and is believed to be non-polluting. This energy source needs much research in engineering, chemistry, physics. One of the problems is around materials - the very high temperatures involved require special materials for handling and containment. Nuclear fusion holds another promise, too - and that is an energy source that is an alternate to burning all of our hydrocarbons (coal, gas, oil) which are also sources for plastics, polyesters, nylons, and the many other materials and products that contribute to our society. Nuclear fission, with its well-publicized problems of disposal of dangerous wastes, has promise of supplying great amounts of energy. Nuclear energy has other problems - locating uranium and mining low grade uraniumores - problems with radioactive wastes, but it is in most scientists' minds, the only hope of meeting the world's needs for energy by the end of this century.

Oil shale is rock-like substance that can contain 10 to 40 gallons of oil (kerogen) per ton of rock - but the retorting process of removing the oil leaves mountains of spent shale - and mountains of environmental problems as well. An alternative is in-situ mining techniques - extracting the oil in place.

Now when I begin this discussion on energy sources, I asked you to think about the kinds of jobs involved as I discussed the sources and problems around related research and development of the source.

Let us look then more closely at the types of applied scientists and engineers that will be most likely to find job opportunities in the growing field of energy.

In location identification - finding gas, coal, oil, etc., there would be need for geologists, geophysicists, mining engineers.

In extracting fluids from the ground, a need for chemists, engineers of all types - but also a specialized type called a reservoir engineer - a specialist in location and removal of oil-gas, water, from its natural location, also for rock mechanics, hydrologists.

In the conversion, transfer and storage of all types of energy - mechanical engineers with strong power background, applied physicists, chemists, heat transfer specialists.

In Porous Flow Problems - applied physicists, petroleum engineers, geophysicists, hydrologists, chemists.

In the Chemical In-Situ Mining Processes - metallurgists, chemists, engineers, (especially civil, mechanical, and chemical), physicists.

In Environmental Problems - (Land, air, water pollution and conservation), chemists, engineers, environmental specialists, hydrologists, meteorologists, applied physicists.

In Nuclear energy - material and optical engineers, nuclear engineers, physicists, metallurgical specialists.

There is an obvious move toward integration of the disciplines in energy research to interrelate, to communicate; pure theorists are too isolated and not as marketable as applied scientists. Most of these applied areas are non-traditional for women -

and thus the opportunities should be greater.

There is another area of jobs involved in the energy field - and that is the support occupations - the technicians and instrumentation specialists who do the measurements, the laboratory testing, the retrieval of data, the mineral assays, the materials studies - and again most of these areas are non-traditional for women with more opportunity possible. This is also the area of less than four years degree - the AA degree level.

Now - to the third question - How do I get there? And this is, of course, where we as parents and as educators can get in the act - and I am going to talk now specifically about helping girls and women get there.

In interviewing the scientists and employment recruiters who contributed the information I have presented here today, there were some common threads in their comments - let me pass them on to you.

1) The "soft" sciences of biology, pure chemistry, zoology, theoretical math are well represented with women - who are having a difficult time finding a market for their degrees. Many are accepting positions as lab assistants. Opportunities are equally as good as for men, but not better.
2) The field of computer science is well represented with women, but primarily in programming, computer operators and keypunch operators.
3) Some areas are not well represented by women - electronics, physics, engineering are examples. Scientific institutions have set goals for increasing their representation of women for these disciplines.
4) Women need more preparation for the work environment of non-traditional fields. They also need more applicable education background.

In the work environment, they need to become accustomed to working with machines, with noise, with a non-office environment - smells of chemistry labs - dust of a mineral assay lab - the language and behavior of the working class. This familiarization needs to begin in early years - with more exposure to mechanics, engineers, tools - the exposure being necessary to stimulate interest in this area. Girls need to take shop in school, to work in gas stations, to overhaul engines. They need exposure to the different work environments with field trips, work experience programs, class speakers, films and other media.

A report of a MIT Conference on Women in Science and Technology outlined recommendations for increasing the representation of women in non-traditional roles in science and technology. I would like to share some of those recommendations with you.

1) To experiment with methods that would attract girls to mathematics, science, shop and technical courses.
2) To actively recruit girls for vocational programs that traditionally enroll only males. Non-discriminatory regulations are necessary but are not sufficient to get them in non-traditional activities at an early age.
3) To build in methods of in-service training for teachers that encourages summer employment which gives credit on the salary scale - or in some way stimulates teachers to get out and find out how their subject matter applies to the world of work.
4) As an educator, keep abreast of science and important research efforts so you are aware of possible trends. In an effort to help you with this, I am providing a bibliography of some very recent articles and books on this subject.
5) To take account of the significance of the school's physical education programs role in forming male and female attitudes about sex roles.
6) To actively encourage girls to take courses that develop their abilities to cope with different environments - like machine shop, electronics, and vocational agriculture.

I think this covers what I wanted to share with you this afternoon about the need for women to prepare for and be aware of the non-traditional opportunities in the field of science.

There is one final point - the importance of making students aware of the continuous process of career planning and development. Traditionally, career decisions were thought to be subject for high school seniors only - but a rapidly changing industrial society has made career planning and development a life-long process. In the Career Planning Program at Lawrence Livermore Laboratory, we emphasize the need for continued monitoring of one's career process - for a need to assume responsibility for one's career - not to delegate such an important task to one's boss - or the company - and expect to be "taken care of". And of course - to be always conscious of the three questions - Who am I? Where am I going? and What am I going to do to get there?

Karol Ruppenthal of the Office of Equal Opportunity at Lawrence Livermore Laboratory has gathered some data that reports various data related to this topic. Jack Brewer, Manager of Employee Development at Lawrence Livermore Laboratory will present this data (attached) and answer any questions you may have.

University of California
Lawrence Livermore Laboratory
SPECIAL PROGRAMS TO PROVIDE TECHNICAL WORK EXPERIENCE

I AFFIRMATIVE ACTION HIRES

The intent of this program is to train applicants who have completed academic requirements, but are lacking in experience, or individuals who have work experience that is not specific to job requirements. Applicants are trained for one year for a professional or technician level job. Over 90 percent of those who complete the program are hired into permanent full-time jobs at the Laboratory. The emphasis is on minorities and women in technical disciplines.

II ON-THE-JOB-TRAINING

This program provides one year of trianing to economically disadvantaged individuals or for individuals excluded from employment opportunities based upon race or sex. Trainees with few or no marketable skills are trained in skills which provide a likelihood of employment both within and outside the Laboratory, typically technician-level or clerical jobs. The emphasis is on minorities and women.

III WORK EDUCATION EXPERIENCE PROGRAM

This program provides part-time (school year) and full-time (summer) work experience to high school and college students whose academic interests are in the technical fields. Emphasis is on women and minorities.

IV CO-OP EDUCATION

This program is designed to provide practical R & D experience for scientific and engineer students to supplement and reinforce their classroom work. Students typically alterante six months study with six months work. The program is interdisciplinary and is open to both undergraduate and graduate students.

V STUDENT EMPLOYEE PROGRAM

Designed to provide research experience and financial assistance for the scientific graduate student, LLL's student employee program offers half-time employment for nine months and full-time summer employment for students of the Division of Applied Science (a branch of the University of California - Davis) located on the LLL site. The program is limited to approximately 50 students, primarily physics and computer science majores at MS and PhD level. For further information contact Dr. Fred Wooten, (415) 447-1100, Ext. 8921.

Inquiries regarding Programs I-IV may be directed to Manuel Perry, Office of Equal Opportunity, (415) 447-1100. Ext. 3951

UNIVERSITY OF CALIFORNIA LAWRENCE LIVERMORE LABORATORY

FISCAL YEAR 1974 - 1975 HIRING

PROFESSIONAL JOB GROUPS	TOTAL	PhD	MS	BS	Less than BS	TECHNICAL JOB GROUPS	TOTAL	NO DEGREE	AA	BS	BS
Administrative Professionals	31	2	9	17	3	Drafting & Mechanical Technicians	67	27	26	14	
Engineers - Mechanical Engineering	49	17	24	8		Electronics Technicians	65	32	29	4	
Engineers - Electronics Engineering	36	10	19	6		Math & Computing Technicians	54	23	25	6	
Engineers - Other	12		1	10	1	Health & Safety	26	3	9	14	
Mathematicians & Programmers	69	8	30	31		Technical Illustrators	8	2		6	
Chemists & Metallurgists	37	17	10	10		Other Technicians	44	21	4	18	1
Health & Safety	14	1	9	4							
Life Scientists	25	12	9	4							
Physicists	120	81	26	13							

ESTIMATES OF NATIONAL WORK FORCE REPRESENTATION OF WOMEN IN MAJOR TECHNICAL DISCIPLINES*

Discipline	Caucasian Women % Total	Minority Women % Total
Engineers	1.6	.7
Programmers & Mathematicians	20.7	2.2
Biologists	33.9	3.1
Geologists	3.4	.2
Chemists	11.0	1.8
Physicists	4.6	.9
Technical Editors/Writers	12.6	1.8

ESTIMATES OF STATE OF CALIFORNIA WORK FORCE REPRESENTATION OF WOMEN IN MAJOR TECHNICIAN OCCUPATIONS

Occupation	Caucasian Women % Total	Minority Women % Total
Mechanical Technicians	3.3	1.5
Electronics Technicans	5.3	2.1
Chemical Technicians	10.3	4.3
Bio-Medical Research & Medical Technicians	58.0	9.1
Draftspersons	9.6	2.2
Mathematical Technicains	No Census Data Available (However, women comprise 28% of the Laboratory's Digital Computer Operators and Computer Technicians)	

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* Based on data collected by the 1970 Census and the 1970 EEO-1 Report for 45,000 federal contractors. Summary prepared by UC Lawrence Livermore Laboratory.

BREAKDOWN OF PROFESSIONAL AND
TECHNICAL JOB GROUPS
UNIVERSITY OF CALIFORNIA LAWRENCE LIVERMORE LABORATORY

PROFESSIONALS

JOB GROUP	% OF TOTAL
ADMINISTRATORS	8.5
ENGINEERS	32.0
PROGRAMMERS/MATHEMATICIANS	13.4
LIFE SCIENTISTS	2.8
CHEMISTS/METALLURGISTS	11.9
PHYSICISTS	29.1
TECHNICAL EDITORS/WRITERS	1.4
TECHNICAL INFORMATION SPECIALISTS	.7
NURSES	.2
	100% (1755)

TECHNICIANS

MECHANICAL TECHNICIANS	31.3
ELECTRONICS TECHNICIANS	26.9
CHEMISTRY TECHNICIANS	10.8
PHYSICS TECHNICANS	4.3
BIO-MED & RESEARCH TECHNICIANS	1.4
EXPEDITERS	2.4
DRAFTSPERSONS	8.2
MATH & COMPUTING TECHNICIANS	9.8
TECHNICAL ILLUSTRATORS	1.5
PHOTOGRAPHERS & REPRODUCING TECHNICIANS	3.1
GLASSBLOWERS	.3
	100% (1489)

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12. JOBS FOR WOMEN IN SCIENCE (CONTINUED): THE BAY AREA SURVEYED

by Sandra H. Slivinsky
Senior Research Engineer
Lockheed Missiles & Space Co.

My reasons for being here differ from those of the people with me today. I do not do any career planning, but rather I am a technical person. I have a degree in physics and a degree in engineering-applied science. And I have one important additional qualification. That is, I have been a job seeker twice in the last three years. So I have some direct experience, as well as some information I have researched, to relate to you today. If you are a job seeker, or a potential job seeker I hope you will take information away with you that is of some direct assistance to you. Since we do have so many teachers here today, I hope you will take data back to your students, to assist in their career planning and possible areas or routes to take through their degree programs.

Since I wanted to be able to give you a view of the available types of jobs throughout the Bay Area, it seemed that sending a letter to every company which I could locate in this area, was the most sensible approach to gathering this information. I attempted to include the entire region from Oakland to San Jose, my major source of information being a listing of the Northern California Industrial Relations Council. In the letter I sent to these companies, I identified the conference and its purpose, myself as a Senior Research Engineer working for Lockheed, and the purpose of our session on jobs in science. I indicated that I could easily give a session on jobs available to women and men at various degree levels in different fields at Lockheed, and that this would clearly not be of very wide interest, therefore prompting my request to them for information on their companies.

This letter went out the first of March, so sufficient time was available to reply before this conference. On the first of April, I sent another letter to several companies which I had omitted in my first mailing. Also, I did that for another very disturbing reason: I wasn't receiving very much information up to that point and was hoping for some additional data. Altogether I sent 96 letters. These were to 75 different companies, so some companies received more than one request (14 letters were mailed on April 1). Out of the 75 companies, I have information to deliver to you today from a mere 17. I would think this is an indication that we have a problem. Now it may be that the job market is currently so small that the companies didn't want to create too much of a job pool that they had to turn away. But then I wasn't requesting hiring information,. just trying to get a picture of what types of people they do employ. We lack information, but we do have something and I know that we can draw some useful conclusions.

It is interesting to note the response incurred by the April 1st letter. I received several phone calls. These were interesting, since they were a mixture of serious information and good public relations. The public relations phone calls were from people informing me that their company was really looking for women, was glad to have received my letter, and was happy to have a change to reply. Now, this sort of call tends to make me angry. Most especially, since one of these callers was from a company which I have interviewed with not 6 weeks prior to this conversation. To say that I was not treated in a professional manner is to be very polite.

Now for the details of what I do have for you. I have catalogued the companies in alphabetical order. I requested information at all degree levels and this is shown, along with major field of specialization. The request was for information in the major fields of mathematics, computer science, physics, chemistry, and biology. Engineering was excluded from the information request, especially since I already had the feeling that engineers were currently more in demand. I received almost no information on biology, which is information in itself. The end result was an influx of data on the engineers of various types being utilized within these companies, while having requested data on the basic sciences.

Consulting the view graphs,(charts at the end of this report), Aeronutronics Ford in Palo Alto says they hire at all degree levels, mainly EE and ME, some math and computer science. They are a space and ground communications company. Chevron Research in Richmond says they hire at all levels and again they seem to be more heavily in the engineering: chemical engineers, mechanical engineers, computer science, chemists, and a general engineer category. They process petroleum products and chemicals. ERDA is based in Oakland and they use management people only there. They hire at the BS and MS levels in chemical engineering, mechanical engineering, industrial engineering, and some physics and biology. IBM in San Jose hires at all levels: chemistry, physics, ME, EE, and computer science. They are an electronics firm and made mention of an important type of person they seek. They say they look for people with hybrid skills:with physics and chemistry background, but also with mechanical and electrical engineering training. It is important to understand why. I think it is because they would like to have people who are capable of moving around within the company, so that, for example, they do not have to layoff 10-20 chemists and hire 10-20 EE's. If they have people who can move around and perform different functions, they can remain at IBM. It doesn't seem that this type of person would only be in demand at IBM. It seems to be common sense to keep your options open so that you can fit into a number of different types of environments and utilize a variety of training.

PG&E in San Francisco is an energy company, hiring at the BS and MS levels: EE, ME, civil engineers, computer science, nuclear engineers, and some mathematics. SRI in Menlo Park may be doing some hiring now, since they sent a job listing and apparently want to fill those positions.

They hire at all levels and please observe the preponderance of engineer types of people. Xerox in Palo Alto says they are looking for chemistry, physics, and computer science types of people at all levels.

My very last chart lists all those companies which did not respond to the survey request. This can be of some value, for example, in locating companies in your general area and companies which you might think would employ someone with your background.

There are some conclusions we can draw from all this, which I have more or less alluded to here. Engineers seem to be more in demand now than the so-called basic or pure sciences, which include chemistry, physics, and mathematics. The training of scientists and engineers is quite different: scientists are taught to ask more in-depth questions and to generate new ideas and solutions, while engineers are taught methods of solving the existing problems. In some fields, theory is well ahead of practice and engineers are required to solve the currently identified problems. In my own experience, in the current job market you can expect a better response if you have differing types of training. This is especially important for teachers to be aware of, since you wouldn't want your students to learn an old specialization, which in five to ten years might not exist. The main point seems to be to keep your options open, by keeping your educational training divergent enough, so that you don't commit yourself to a specialty which may be of interest to you at some time, without constantly keeping in mind the requirements of the job market.

Another idea worth mentioning again here at this conference, is the notion that the requirement for the PhD is virtually gone. This is especially dangerous for us as women, because it is not true. It is true if you don't want a research job or if you don't eventually want to get into management. But if you do want these things, then you better have a PhD, because PhD's are still filling those jobs. There may not be many jobs currently, but the best ones are going to be offered to the people with the most education. I am appalled by women telling me that it is no longer necessary to have PhD's, since we are the last people who can stop having the most degrees needed for a job. In addition, it should be apparent that in the sciences, the best paying jobs go to the best qualified, which generally are considered to be the people with the highest degrees.

I have several conclusions other than the ones we have been able to reach directly from viewing these charts. There is a mythology which exists now and it is called, "We are looking for women." And it is that: a mythology. I do not wish to put down the one or two companies who might actually be looking for qualified women. However, companies do not seem to be actually looking for women, more just saying that they are looking. Now there is some hiring of women by these companies and we need to look at just who is getting hired. The women that are being hired are those right out of school with bachelor degrees and at the enormous salary of ~$10,000 a year. Then the company can relax, making note of the fact that they have ONE: a woman. It is just incredible that we find this when we look behind the facade. Some of this is changing, but not nearly fast enough.

I believe it was suggested this morning that if you are earning more than ~$15,000, there are some immediate problems. What do you do if you are at the intermediate salary range? Check whether the company has an affirmative action program. It doesn't even have to be a fully operational affirmative action program. The existence of this program at least means that someone is thinking or is being forced to think about the problem. If you try to look at companies with one to few hundred level persons, you are going to have a difficult time, unless you find a group which does not need to consider the fact that you are a women, in addition to your qualifications for the job. As an intermediate salary range person, I have been very close to one or two job offers with small companies, which suddenly fell through at the last instant. A continuing conversation suddenly ceased and I had the feeling that the hiring request went to upper management, where it was stopped. Perhaps it was not the right time for a women in that position, and/or it costs too much. I was then politely informed that there was no fit between my background and their current requirements.

You have probably heard this before, but it is so important that it should be repeated again and again. Your best way to find a position is through personal contacts. You can receive responses through writing to personnel departments, but you have a far better change of finding the job you are suited for, if you locate the people cognizant of evaluating your qualifications against their job requirements. Especially in the case of a woman seeking a job, this may help surmount the barrier which exists in the hiring of women.

Now for what you can do as potential job hunters or in dealing with other people who are job hunters in the current job market. You need an extremely positive attitude and a well thought out idea of what kind of job you want. It is no longer enough to have a degree or several degrees. It is not an automatic result that a bachelors or masters in some field means you will have a job in that field in your chosen specialty. There aren't many jobs, and so you need to have an idea of exactly what type of work you want. Moreover, you want to convey the assets you bring to the company or organization with which you are trying to find a job. Learn what you can about the company and offer to solve their problems with your expertise.

In conclusion, it is a difficult time for finding a job. There seems to be a current heavy emphasis on engineering types of people, and also for people with hybrid backgrounds. I think this is especially important for teachers to know and transmit to their students, so that students keep their options open. I think women need more assistance getting job market feedback than men do. They should not be permitted to take courses without keeping in mind the job possibilities open to them.

I think women do not have ready access to this type of feedback for a very poor reason. There is always this feeling that a woman is not going to work anyway, and that therefore, it doesn't really matter what courses she is taking or for what job she is preparing herself. This is a very unrealistic attitude in our present society. There are many serious technical problems remaining to be solved, and the female portion of the work force is needed, as much as the male part of the work force, to solve them. In addition, women have always been a large portion of the work force, so why then, shouldn't they have the highest paid and the most rewarding jobs? As women we can help other women find their ways in life. This feeling is part of the marvelous esprit de corps that has been growing amongst us and it should be nurtured. We need to keep those around us constantly aware of the job market and the qualifications required, so that all of us can lead more satisfying, productive lives.

COMPANY & LOCATION	DEGREE	MAJOR FIELD	COMPANY TYPE	JOB TYPE (IF SPECIAL)	HIRING
Aeronutronic Ford, Palo Alto	BS	EE, ME Math, CS	Space & Ground Communications		
	MS	EE, ME MBA			
	PhD	EE, ME			
Airco Temescal, Berkeley	BS	EE, ME, IE Engr	Vacuum Equipment		No
	MS	EE, ME Engr			
	PhD	Engr			
Atlantic Richfield, San Mateo	BS	CE, ChE EE, ME Chem, Geophys	Natural Resources & Production		
	MS	ChE, CE EE, Geophys Chem, ME			
	PhD	Geology, EE Petroleum Engr ChE, ME			
AT&T Long Lines, San Francisco	BS		Communications	Management	
Chevron Research Co, Richmond	BS	ChE, ME CS, Chem Engr	Petroleum Processing, Products & Chemicals		
	MS	ChE, ME CS, Chem Engr			
	PhD	ChE, ME CS, Chem Engr			
Clorox, Oakland	BS	ME, ChE	Manufacturing and Production		
	MS	ME, ChE			

COMPANY & LOCATION	DEGREE	MAJOR FIELD	COMPANY TYPE	JOB TYPE (IF SPECIAL)	HIRING
Energy Research & Development Association (ERDA) - Oakland	BS	ChE, ME, IE Phys, Biol.	Monitors Research and Development	Management Only	
	MS	ChE, ME, IE Phys, Biol.			
ESL, Sunnyvale	BS	Math, Phys CS, EE	Software and Hardware Computing		
	MS	Math, Phys CS, EE			
GTE Lenkurt, San Carlos	BS	CS, EE, ME	Communications and Electronics		
	MS	CS, EE, ME			
GTE Sylvania, Sunnyvale	BS	ChE, CS, EE IE, ME, Math Phys, Chem	Communications and Electronics, Lasers		
	MS	ChE, EE, IE ME, CS, Math Phys, Chem			
	PhD	EE, Phys			
International Business Machines (IBM), San Jose	BS	Chem, Phys, ME EE, CS, Phys Chem	Electronics	Hybrid Fields Useful	
	MS	Chem, Phys, ME EE, CS, Phys Chem			
	PhD	Chem, Phys, ME EE, CS, Phys Chem			
Kaiser Aluminum & Chemical Corp., Oakland and Pleasanton	BS	ChE, ME, EE Chem, Math	Aluminum Products and Industrial Chemicals	Research and Development (Pleasanton)	No
	MS	ChE, ME, EE Chem, Math			
Lockheed Missiles & Space Systems, Sunnyvale, Palo Alto	BS	AE, EE, ME, Math Phys, Chem	Missiles and Space Systems		
	MS	AE, EE, ME, Math Phys, Chem			

COMPANY & LOCATION	DEGREE	MAJOR FIELD	COMPANY TYPE	JOB TYPE (IF SPECIAL)	HIRING
Measurex, Cupertino	BS	ME, ChE, EE Math, Phys Engr	Software Computing		
	MS	EE, Engr			
Pacific Gas & Electric Co., San Francisco	BS	EE, ME, CI Nucl E, CS Math	Energy		
	MS	EE, ME, CI CS, Nucl E Math			
Raychem, Menlo Park	BS	Chem, Phys Biol.	Heat Shrinkage Tubing, Corrosion Prevention Devices	Plastics Background Helpful	
	MS	Chem, Phys Biol.			
	PhD	Chem, Phys Biol.			
Signetics, Sunnyvale	BS MS PhD		Electronics Manufacturing		
Stanford Research Institute (SRI), Menlo Park	BS	EE, Math, ChE Chem, CS, Phys	Research		Some
	MS	EE, ChE, CS Math, Chem Phys			
	PhD	EE, CS, Chem Phys			
Standard Oil, San Francisco	BS MS PhD	CS, Math, ME, CE, ChE Chem	Natural Resources & Production		
Varian, Palo Alto	BS	EE, ME, IE Chem, Phys	Vacuum Systems, Analytical Instruments		

COMPANY & LOCATION	DEGREE	MAJOR FIELD	COMPANY TYPE	JOB TYPE (IF SPECIAL)	HIRING
Westinghouse, Sunnyvale	BS	ME, AE	Missiles, Strategic Systems		
	MS	ME			
	PhD	ME			
Xerox, Palo Alto	BS	Chem, Phys CS	Research		
	MS	Chem, Phys CS			
	PhD	Chem, Phys CS			

Companies polled but not responding:

Company	Location
Alza Corporation	Palo Alto
American Tel & Tel Company	San Francisco
Ampex Corporation	Sunnyvale, Redwood City
Baines Associates, Inc.	San Francisco
Barnes-Hind Pharmaceuticals, Inc.	Sunnyvale
Bechtel Corporation	San Francisco
Berkeley Bio-Engineering, Inc.	San Leandro
Bio-Rad Laboratories	Richmond
Buttes Gas & Oil Company	Oakland
California Canners & Growers	San Francisco
California & Hawaiian Sugar Company	Crockett
DCA Reliability Laboratory	Mountain View
Del Monte Corporation	Berkeley
E&J Gallo Winery	Modesto
Envirotech	Belmont
Exxon Company USA	Benicia
Fairchild Camera & Instrument Corp.	Mountain View
FMC Corporation	Santa Clara, Newark
Fireman's Fund Insurance Company	San Francisco
Foremost International	San Francisco
Foremost - McKesson, Inc.	San Francisco
Gentry International, Inc.	Gilroy
Gulf Oil Company	Hercules
Hewlett Packard	Palo Alto, Cupertino Santa Clara

Company	Location
Hunt-Wesson Foods, Inc.	Hayward
Intersil, Inc.	Cupertino
Kaiser Aerospace & Electronics Corporation	Oakland
Kaiser Permanente Medical Center	Oakland
Kraft Foods	San Francisco
Litton Industries, Inc.	San Francisco
Litronix, Inc.	Cupertino
Medi-Phys, Inc.	Emeryville
Monsanto Electronics Division	Palo Alto
Optical Coating Laboratory, Inc.	Santa Rosa
Pacific Molasses Company	San Francisco
Pfizer, Inc.	Emeryville
Raytheon Company	Mountain View
RCA Global Communications, Inc.	San Francisco
Shaklee Corporation	Hayward
Siliconix	Santa Clara
Singer Company	Palo Alto
Spectra-Physics, Inc.	Mountain View
Spreckels Sugar Division - Amstar Corporation	San Francisco
Stauffer Chemical Company	Richmond
Transamerica Computing Company	San Francisco
United States Navy	San Francisco
United Technology Center	San Jose
United Vintners, Inc.	San Francisco
Utah International Company	San Francisco
Zellerbach Papaer Company	South San Francisco

Question Period - JOBS FOR WOMEN IN SCIENCE

Q. None of you seemed to mention the fact that most young women enter the job market completely ignorant as to how to present themselves at an interview. They do not seem to know the proper dress and how to conduct an interview. I was wondering if anything was being done in this area to educate women.

A1. I believe that in some education programs this is part of a specific class, say in junior high school. Such inclusion into the educational process would be highly recommended and would seem to be very important. Most of our work at Livermore has been with people who are changing careers, who have already chosen a career and want to change directions.

A2. I think that much of this type of education is being done on a personal level. The Society of Women Engineers tries to do this on a more formal level.

Q. How do you treat the problem of women re-entering the job market after child rearing?

A. That is a whole additional area. There are some programs and training programs for such women. These focus on women who are willing to work after their children are grown and are for women who either have or do not have degrees. Some of the successful re-entries can be linked to exposure at some point in life, which is not necessarily degree-related. I know of a woman who became the first female to operate the generators at San Francisco PG&E, solely because she could identify the different types of machinery in the plant, due to earlier descriptions by her father.

Q. Does Lockheed actively seek women for their higher level positions?

A. No, Lockheed does not actively recruit anybody for higher level positions. They hire all people at entry level positions and they rise through the ranks. (Answered by Lockheed's Affirmative Action Representative.)

Q. I heard, from women who work at Lockheed, that women have tried to rise from the lower levels but are generally kept in their places and not permitted to reach the higher positions.

A. That is changing. There has just been an increase in the number of women in higher level positions. There are goals and time-tables which span the next seven years which have been recently set by court order. So it has to change. (Answered by Lockheed's Affirmative Action Representative.)

Q. In terms of affirmative action, it seems that there is some action put into recruiting women and minorities, but when it comes right down to committing an offer, the hiring is not an affirmative action at all.

A. That seems to be along the lines that we have discussed here today.

Q. I sent a letter to Lockheed in Santa Cruz in answer to an advertisement for technicians and secretaries, even though I had a degree in mathematics. They told me to come in for an interview and it worked out very well for me.

A. Yes, writing to personnel departments should not be neglected. They might just need the qualifications you have to offer.

Q. How much of a chance would a woman have in re-entering the work force when her competition is with new MS and PhD people?

A. If such a person demonstrated in a seminar, to people that would be interested in hiring her, that she had the knowledge in the job area she was applying for, that would be what is required. She would not be categorically discriminated against for being outside of the work force for some period of time.

Q. Do I understand you to say that the personnel department is not the best route to a hiring situation?

A1. The personnel department is a screening out device. The first big screening out of people takes place in the personnel department and if you are clever you will attempt to bypass this obstacle.

A2. I appreciate your emphasizing that point since it becomes particularly important as you move up in salary. The higher salaried jobs are not to be had through the personnel department, no matter who you are, man or woman.

Q. As a point of information I offer the following. In making personal contacts, organizations like the Society of Women Engineers and the Association for Women in Science, can be of great assistance. I am a member of SWE. In the last year I must have had six to eight phone calls from both men and women, who either have no jobs or are trying to transfer into General Electric where I work. Some of these people I haven't seen in years, if in fact I have ever met them. Either I can tell them if we have such jobs or not, or I can direct them to someone in an area utilizing their capabilities, and have them call using my name. This is the way contacts are made and you should feel free to use them. You have to be sort of brash about this and figure the worst that can happen is that you will not get any information - and then you will have lost nothing anyway.

Q. I was interested in what was said about hybrid (background) people. I think that people should be encouraged to be hybrid people in the sense of interfacing between two areas. Not many people will be qualified in these areas and the jobs that do exist will be unusual and interesting. They will probably be higher paying as well. If I were a young scientist now, I think the most interesting type of job would be to become an ecologist with a background in biology. Such a person could deal with the problems brought about for people with increasing energy production.

A. That is an interesting comment and it is particularly apropos to combine biology with another field, since biology itself does not seem to be in demand now.

13. A COUNSELOR'S PERSPECTIVE

Jackie Yokote
Thornton High School

The methods for counseling women in science and mathematics is very much tied to counseling women in general. Women's consciousness raising is a very real and needed area in our counseling programs. There is a frustration among counselors because many young women are so unaware of the fact that they need counseling and guidance as women.

How do you get young women to join women's groups? Suggestions included the following suggestions. The counselor should: (1) Identify those young women the counselor can have an impact on. The first women's group must be highly successful so that other young women will be anxious to take part in those groups that follow. The counselor can increase the probability of a successful group through this selection process. (2) Explain the goals of the group to all counselors. This process can be done through english classes, P.E. classes--whatever is practical. During this mass selling job it is important to tell the students that success just doesn't happen. Success is planned for and prepared for. Success takes training. Young women are usually trained to be wives and mothers, if by no other means than by watching their mothers. They are hearing a lot about doing other things in place of or in addition to the traditional wife and mother roles (a good time for a woman in math and science plug!). What is heard can be very exciting but can be frightening because there aren't a lot of women they can see who have accepted the challenge and shared their success with them. The women's group would give them an opportunity to talk with women in traditionally male professions. (3) Personally talk to those individuals discribed in step 1. The contact doesn't have to be a formal one. A comment in the hall is sufficient to let a student know the counselor cares about her and would like to work with her. This step helps insure group membership.

Other topics discussed included: As counselors, should we ignore, foster, or de-emphasize female qualities as we prepare our young women? Frustration was expressed because of the decrease in enrichment classes in the elementary and junior high schools.

The remainder of the time was spent discussing the Japanese American's experience in America in general and the Japanese women's experience in specific.

14. COURSES ON WOMEN IN SCIENCE[1]

Barbara D. Webster
Department of Agronomy & Range Science
University of California, Davis 95616

Courses on Women in Science have been developed for the most part at the college level. However, their purposes and content may be as relevant to high school as to college students. My comments this afternoon derive principally from courses presented at colleges and universities but I think you will see that the remarks can generally apply to younger aspiring scientists and to counselors and teachers of high school students.

The impetus for development of courses on women in science stems from the fairly recent resurgence of interest by women in careers in science, which may in turn be related to implementation of affirmative action programs at colleges and universities and in science-oriented industry. Women in Science courses are designed to retain women students in scientific disciplines, to attract young women to programs in science, and to encourage established women scientists who have interrupted their careers to resume active participation. Depending on the status and background of course enrollees, the course contents vary but in the main focus on four major areas of interest: 1) participation of established and not-so-established women scientists as visible role models; 2) analyses of problems unique to women scientists; 3) career development counseling; and 4) job market analysis. This afternoon I would like to comment generally on each of these aspects.

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[1] The author expresses sincere thanks to Jane Kimball, reference librarian at Shields Library, University of California at Davis, for assistance in literature search.

I. Women scientists as role models.

In 1973, the American Council on Education reported a nationwide increase in numbers of young women interested in or initially electing a college science curriculum. However, it also noted that the majority of these women were lost to the science disciplines as a matter of choice less than 4 years later. At Purdue University, for example, approximately 20% more women than men left the school of science, usually by the end of the freshman year. It was demonstrated that leaving was not generally related to poor academic performance of young women but was perhaps a consequence of the lack of visible role models.

Under a grant to Purdue from the Fund for Improvement of Post Secondary Education, an agency of HEW, a Women in Science course was developed by Dr. Martha O. Chiscon as part of a concerted effort to stem the attrition of qualified women from the school of science. One important facet of the course involved guest lecturers. These were women not employed at Purdue, selected not only for their scientific expertise but to represent a spectrum of age, career status, life styles and professional and personal philosophies. Guest speakers lectured in both formal and informal meetings, and sessions were videotaped for future reference. Students in the course (all of whom were women) prepared in-depth reports on each speaker and on the speaker's area of interest. The rather intense contact period extended for 2 days.

The Purdue course format involved counseling (of which more will be said), as well as presentation of role models. At the end of the 2-year experimental program, 62% of the women in the school of science who participated in the program remained in science, as opposed to 49% of those initially in science but not in the program; thus the retention of women in scientific disciplines was increased by 13%. Interestingly, the 62% retention of young women in science exceeded that of men by 6%.

A Women in Science course at the University of California at Davis followed a different format, using women employed in science departments on that campus as role models. The women ranged in rank from laboratory technician to professor. Each discussed both her background and training and her current research programs. Presentations tended to be more general than technical. The audience consisted of undergraduate and graduate students, a few high school students, university faculty, townspeople (including particularly senior citizens) and men and women in industrial research.

At the University of California at Santa Cruz, a Women in Science course organized by Ellen Switkes brought to the campus women with expertise in matters of particular interest to young women. Guests included a woman physician, a woman involved in scientific research in industry, and a woman familiar with details of affirmative action guidelines, programs and implementation.

A forth variation on the role model course format was developed at California State University at Sacramento. This was a History of Women in Science course, designed to acquaint students with significant contributions of their predecessors in science, mathematics and medicine. The course involved study of biographies and scientific contributions of women in science and analysis of cultural and psychological bases for the current underrepresentation of women in science. Also at Cal. State, under the Continuing Education courses for women, students were introduced to careers currently regarded as atypical for women. Women from the local community, including scientists, who held significant positions, discussed opportunities in their chosen field, professional training required and how to get it, and how to gain entrance into the profession.

II. Problems unique to women scientists.

Women in professional occupations share a number of interests and common concerns with all working women. Women in science, however, have some unique problems and concerns to which Women in Science courses have directed attention. The first of these relates to science as a male-dominated discipline. The fact is that Western Science has been produced almost exclusively by men. This, as Ruth Hubbard notes, would be irrelevant to the content of science if one believed the myth that science is an objective description of reality and as such unaffected by one who perceives and portrays it. But science is produced by people, whose perceptions of what constitutes reality are shaped by their social and personal environment from birth. It would therefore be surprising if the content of present-day science did not in some way reflect its masculine lineage. If women had constituted half the scientific work force since the time western science broke away from its medieval precursors, its structure and content would be different--it would have addressed different questions and probably found different answers. One of the easiest places to see this, Hubbard points out, is in medical science. Here the fact that the definitions of health and disease have been established by men has had the odd result that all women's normal, but specifically feminine functions--menstruation, pregnancy, childbirth, lactation, menopause--have been defined as diseases requiring medical attention and/or intervention. When in the 19th century, medicine was divided into specialties there came to be two--obstetrics and gynecology—to deal with women's "illnesses," but the specialty of andrology-diseases of men-was considered briefly and deemed unnecessary.

The results of male dominance in science are that most science teachers are male and so are administrators in schools of science. Most decision-makers in granting agencies, including NSF and NIH, are men, and most research projects submitted for consideration for funding are formulated by men. The editors and editorial boards of most scientific journals are men, and with rare exception, the prestigious prizes in science go to men. Lecturers in Women in Science courses, noting this situation, have stressed that competence of a woman scientist may not be the limiting factor in her career development, but opportunities to achieve recognition and to perform in a significant manner may very well be. In his discussion of "Games Scientists Play," A. C. Leopold notes that out of the generous number of people trained to the Ph.D. in science, relatively few remain active in research. This appears due in large part to the failure of training systems to give young students awareness and enthusiasm for competition. To achieve positions of distinction he feels they must be willing to take the buffeting that is a natural part of the aggressive and competitive interactions with other scientists. For young women, motivation, competitiveness, and aggressiveness are of particular concern when the profession is so male-dominated.

A second problem related uniquely to women in science concerns the additiveness of the scientific disciplines. This poses particular difficulties for women who frequently encounter interruptions in their scientific pursuits. Women in Science courses, presenting discussions of the nature of the scientific discipline, have stressed the fact that when access to good libraries, stimulating colleagues, and special equipment becomes difficult, and when the discipline is fast-moving (as are most fields of science), the recovery period and re-entry time for women whose scientific pursuits are temporarily delayed presents special problems. Young women need to be appraised and prepared to cope with career interruptions and to avail themselves of programs designed to facilitate re-entry. Radcliffe College's Institute for Scholars has developed with this in mind, providing a parachute for those who feel as though they are leaping into space after a time away from professional pursuits.

III. Career Development Counseling.

A third component of courses for women in science is career development counseling. One of the most pertinent questions addressed to young women in counseling them regarding careers in science is, "How does it fit in with what you want to be doing ten years from now?" Identification of what she wants to do is of primary importance; evaluation of choices and options then becomes directional and meaningful. Counsel is also given on selection of a thesis problem or honors project. It may be helpful to young women scientists to be reminded that Madame Curie chose to do her thesis on radium because it was of so little interest to her competitors that she thought she could manage it at her own pace along with family responsibilities. It appears she managed very well.

In addition to the subject matter, the extent of counseling appears to be of importance. The Women in Science course at Purdue, which focussed on role models, involved additional periods of counseling for women participants. One counselor handled a total of 20 students, meeting each student 4 times each semester for approximately 45 minutes per session. The usual counseling program involved one 30-minute session per student per semester. The results of intensified counseling (coupled with the role models) in reducing attrition of women scientists have been discussed.

IV. Job Market Analysis.

The final aspect of most courses on Women in Science is concerned with the job market. Students are generally advised that the single most productive source to find jobs for qualified young women is word of mouth, and of late the "old buddy" system has been supplemented by what Dr. Ramey has called the "old biddy" system, to pass the word. Implementation of affirmative action programs at colleges and universities has resulted in widespread advertising of positions and reading the ads is useful not only for position seeking but as an introduction to the kinds of talents in demand. Recognition of the variety of work opportunities available to women scientists is important in view of the complications which frequently develop as their training progresses. Recognition also of the realities of part-time and full-time employment is stressed in Women in Science course formats.

Alice Rossi (see "Women and the Scientific Professions") feels strongly that part-time employment for women scientists has been misused to the point where it has frequently become a panacea for avoiding a more basic change in the relations between men and women, a means whereby, with practically no change in the man's role and minimal change in the woman's, she can continue as the same wife and mother she has been, with a minor appendage to these roles as an intermittent part-time professional. But competent women scientists deserve more and better in their professional pursuits and must be encouraged to aspire to greater achievement professionally than most part-time jobs can ever provide. A notable exception in this regard appears to be the developing interest in hiring wife-husband teams to fill one full-time appointment. At Mt. Holyoke College, for example, Assistant Professors Sue Ellen and Peter Gruber both teach and carry on excellent research programs under one full-time appointment in the Department of Biological Sciences.

In a discussion of employment prospects and academic policies relating to women in science, Hilda Kahne has suggested that both men and women in science are apt to be adversely affected in the job market by problems besetting the fields of science in the 1970's. But because of the limited range of science specialties in which women concentrate and because of their low rate of participation in specific areas, she feels that women are more vulnerable than men in a tight or fluctuating job market. Kahne notes that women are not entering fields where shortages in trained personnel are expected and that unless women's professional training within the fields of science becomes more diversified, the consequences for them and for society may be compromising.

Women in Science courses have stressed the fact that women scientists characteristically comprise a well-educated group, concentrated in a few fields, earning less than men with comparable degrees. There is a need for women to understand the functioning and projected development of the economy and to consider what may be viable alternatives in degree offerings: combined medical and law degrees, opportunities in education and publications in science and in relatively new fields such as bioengineering.

This country seems to proceed on the theory that one does not really expect significant contributions from the majority of women in science. Perhaps the most disheartening aspect of this attitude is the widespread feeling among men that even if women were equally represented in many primarily male fields, their impact would not be very great (Ferguson, 1966). Ruth Hubbard quotes a recent article by E. O. Wilson, Professor of Biological Sciences at Harvard University which states, "My own guess (sic) is that the genetic bias is intense enough to cause a substantial division of labor even in the most free and egalitarian future societies... Even with identical education, and equal access to all professions, men are likely to continue to play a disproportionate role in political life, business, and science."

Through courses on Women in Science attempts are currently being made to reinforce young women's aspirations to achieve professional recognition. We are hopeful that the results will lead to greater expectations, greater personal fulfillment, and greater recognition of the accomplishments of women in science. As a spin-off, it is hoped that recognition and achievement in science by women will result in greater support of women in the profession by other women and by men.

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WHAT NEXT?

Dr. Jean Fetter

When this conference was in the preliminary planning stage, I was convinced about one thing. This initial meeting of Bay Area women, which has addressed itself to the question of "Why educate women as scientists?" is not enough. We must now ask (and I am assuming we are all convinced that there is a problem) "What can we do about it?" I have a number of suggestions to make; then I'd like to hear your own ideas. In what I say, there will be a number of references to today's discussion groups that might prove frustrating if you were not present. I am delighted to report that Syntex Corporation has generously agreed to publish the complete proceedings of this conference and mail a copy to each participant. I hope you can share these proceedings with your colleagues and students who were not here today.

What is already available in the Bay Area?

There are a number of organizations which can be a source of mutual support.

AWIS: The Association of Women in Science has its national headquarters in Washington but the regional representative is Dr. Marion Smith in the department of neurology of Stanford University. This organization is dedicated "to promote equal opportunities for women to enter the professions and achieve their career goals." It has a newsletter, registry and employment service. Dr. Estelle Ramey was its President in 1974. With enough support in the Bay Area, we could generate some stimulating and productive local meetings.

SWE: The Society of Women Engineers has goals similar to AWIS for women in engineering. The local president is Shirley McDonald at Lockheed Missiles and Space Co.

CWHE: California Women in Higher Education is "the only state-wide organization committed to advocating, protecting and promoting the status of women in California higher education". Its membership is open to all persons interested in working actively for its purpose. The current president is Fanny Rinn, Associate Dean of Social Sciences at San Jose State University.

WAM: Women and Mathematics is administered by the Mathematical Association of America (MAA) Committee on Secondary School Lecturers. This is an excellent organization which sponsors visiting lecturer programs to secondary schools. In the Bay Area, the coordinator is Mrs. Jean Pederson of the

Department of Mathematics, University of Santa Clara. Any Bay Area high school is eligible to participate. The entire cost of the program is borne by the Mathematical Association of America under a grant from IBM. I'm sure a number of the WAM guest lecturers are here today; they were all on our mailing list.

AWM: The national Association for Women in Mathematics has Professor Lenore Blum of Mills College as its current president. Founded five years ago, this association is concerned with improving the position of women in mathematics and encouraging women to study and enter careers in mathematics and related fields. Services include a Speakers Bureau, a Job Register and Newsletter. Local AWM members are involved in programs such as "Math for Girls" and "Women in Science" aimed at encouraging young women to study mathematics.

A number of national organizations have committees on the status of women in their fields: the American Institute of Chemists, the American Chemical Society, the American Physical Society, the American Societies for Cell Biology, Microbiology, Biological Chemists and Biophysics. I am uncertain how active these national groups are. It is not easy to develop regional programs with a chairperson in Chicago or Cambridge or Washington, as is the case with these groups. If you don't want to join a society, there are some other Bay Area possibilities. The Lawrence Hall of Science at Berkeley has developed several programs for pre-college students in math, biology, physics and chemistry. One of these was the basis of a discussion group today, led by Nancy Kreinberg and Rita Liff.* Almost every college campus has a Women's Center which you can contact for resource information. There are some interesting regional cooperative programs in science: The 3-2 Program at Mills is a good example; students may spend 3 years at Mills and 2 years in the engineering program at Stanford or UCB. The Foothill-De Anza Community College district has developed a successful program called "New View"; this is a vocational internship program for women, conducted in cooperation with NASA/Ames Research Center. Some of you heard about this in Peggy Shoenhair's discussion group. NASA/Ames also has a University Consortium program for four-year colleges under the directorship of

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* A conference for nearly 300 high school girls interested in science and math, "Expanding Your Horizons" was held at Mills on March 20. A proposal to continue this work was recently submitted to the Office of Education.

Joyce Summerfelt at Moffett Field. The Stanford Engineering department has developed an instructional television program that is broadcast to local industries. Details of this were given in Mary Lou Allen's discussion group on cooperative programs in engineering. The Industry Education Council of California, (IEC) located in Burlingame has a career education project sponsored with the U.S. Office of Education. San Francisco and Sequoia School Districts are developing career education programs for (among other subjects) science and math. "How To" materials will be completed this spring for teacher use throughout the state. In addition, they have initiated a Bay Area Cooperative Education Clearinghouse, involving a consortium of 18 Bay Area Community Colleges, to place students in business and industry. Pat Hubbard is the director of this IEC Community College project.

As former Labor Secretary Willard Wirtz urged in a recent National Manpower Institute report, education and work should be better integrated instead of being "totally isolated chapters" in people's lives. Projects designed to mesh education and work could be used to great advantage for women in science, as Mills College has discovered in a highly successful summer program with IBM. Mills undergraduates worked as interns at IBM in San Jose during the summer vacation; one student even produced a paper on the project she was given.

If you are interested in a job or career guidance try Dial-A-Job or Crossroads. Dial-A-Job (tel: 415-941-7270 is a taped announcement of certified and non teaching openings.for Foothill-De Anza district. U.C., Santa Cruz also has a tape and other community college districts may have similar systems. Crossroads is a new non-profit institute of for career development in Berkeley, directed by Dr. Mildred McClosky, a former director of education for Catalyst. (Catalyst is a non-profit, national organization which develops and expands career options for college-educated women. Crossroads is a member of Catalyst.) Its aims are to help adults who are choosing a first career or seeking to pursue a second one, who want to investigate new career possibilities or move ahead in their present jobs. What can YOU do in your present position? High school teachers please contact the Women and Mathematics (WAM) program or your nearby colleges and industries for women scientists to come and talk to your classes. Counselors and Womens' Centers please encourage your girls to take more mathematics; investigate and provide information on career options for women in the sciences and make sure your students are aware of these possibilities. If you are a scientist in industry, offer your services to your local high school. College faculty could consider developing a course on "Women in Science." Barbara Webster today gave details of such courses. Mills College has run an outstandingly successful "Women in Science" program, funded in part by the San Francisco Foundation and the IBM Corporation. At the start of its second year, enrollments in math classes had increased 160% since the program began. Martha Chiscon, a professor of Biology at Purdue, also developed a successful course under a two-year grant from the Fund for the Improvement of Post Secondary Education (an agency of HEW). The results of the first year of their study indicated a clear reduction in the attrition rate of women in their group. They had found previously at Purdue, that 20% more women than men left the school of science--usually by the end of the freshman year. The attrition rate in the experimental group of women now is comparable with that of men. I have details of the experiment, if anyone would like to see them.

In 1974 and 1975, the National Science Foundation (N.S.F.) funded 28 studies and experimental projects related to careers in science for women. Details of these projects may be obtained by writing directly to N.S.F. in Washington. They may give you some further ideas for effective programs. Barbara Kirk, who led one of today's discussion groups, was the director of one of these projects.

Much to our delight (speaking of N.S.F. projects) the N.S.F. recently sent out the description of a program competition for science career workshops for women. As a result of the cooperative Bay Area efforts in organizing today's conference, Mills College submitted a proposal to the N.S.F. If it is funded, and the chances are good, Mills will host a two-day conference next February for freshman and sophmore college students drawn from all Bay Area colleges.

It is impossible to resist some concluding remarks about affirmative action, a responsibility we can all share. Dr. Ruth Hubbard, the first woman to be tenured in the Biology department at Harvard, commented "I don't know if affirmative action had anything to do with my being hired at this time, but being a woman had something to do with not being hired before." In a January issue of the Berkeley Gazette, it was reported that at U.C. Berkeley, the ratio of women and minority faculty appointments is declining despite a much-publicized affirmative action plan. A common justification for not hiring women or minority faculty is "there was no qualified person available." This excuse may be justified in 1976; but we can, and should ask such departments "What are you doing about this fact?" F.P. Thieme, writing in a recent issue of Science magazine, suggested that the affirmative action objective would be enhanced by a program of early identification and training of talented women and members of minority groups. The carrot is always more powerful than the stick. Our active encouragement of the education of women for science is a step in the right direction.

In closing, I should like to thank Mills College for its generous and enthusiastic reception of this conference. I have received a great deal of help and advice from a number of people in organizing the program; the panelists and discussion leaders have willingly given time and support. Thank you to all of you for giving up a Saturday with your children, in the laboratory or on the tennis courts. One person in particular has done more than her share. Please join with me in thanking Doris Herrick, Mills College and colleagues throughout the Bay Area.

Conference Questionnaire

1. What do you think has been the most useful and constructive part of today's program?

2. In which way do you think the conference could have been improved?

3. Do you have any suggestions to develop cooperative efforts between Bay Area women interested in math and science?

4. What action would you recommend to influence educators and scientists who are unaware of the problems of educating women for science?

5. Please feel free to make any other comments.

SUMMARY OF "EDUCATING WOMEN FOR SCIENCE" EVALUATIONS.

Approximately 60% of the 240 participants returned an evaluation form. Participants were essentially unanimous in their positive response to the conference. A summary of the main comments is given below.

Particular likes:

Talking to determined women; Estelle Ramey; discussion sections, high quality of participants; everything; job opportunities; just doing it; inspiration; community feeling.

Improvements:

1. Arrangements to attend more than 1 discussion group.
2. More perspective for women without Ph.D's and outside academe.
3. More advertising before conference.
4. More time for questions.
5. Shorten lunch hour; include lunch speaker.
6. Offer current job information for each specific field; employers should be available at conference.
7. Invite all science faculty.
8. Make conference longer.
9. Allow for more contact with speakers.
10. Issue "statement of concern"; include ethics of science.
11. Include minority women on panel.
12. Involve more women from industry.
13. Ask women panelists for their ideas, not life stories.

Suggestions for future:

1. Improve early career counseling.
2. Establish network in industries.
3. More such conferences (many such comments).
4. Publish newsletter
5. Present papers at professional meetings on this subject; publish articles.
6. Take this program into companies and schools.
7. Develop a T.V. program on this topic; distribute A/V material to schools.
8. Encourage local meetings; regional counselling centers.
9. Similar meeting for elementary school teachers; high schools; colleges; parents.
10. Arrange tours of industry for teachers and counselors..

Note added in June 1976.

It has been very encouraging to learn of a number of Bay Area activities stimulated by the conference: a cooperative proposal to the National Science Foundation on career workshops in science; a community college conference on women in science; a college course on women in science; a university conference for women in physics, math and engineering; a meeting for high school faculty and students in science and mathematics.

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